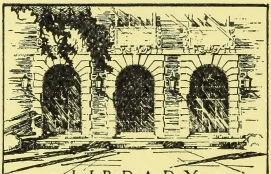

ANNUAL REPORTS

OF THE

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1903.

VOLUME XII.

REPORT OF THE CHIEF OF ENGINEERS.

PART 4.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

ARRANGEMENT OF THE ANNUAL REPORTS OF THE WAR DEPARTMENT FOR THE YEAR ENDED JUNE 30, 1903.

Volume I.—Secretary of War:

Chief of Staff.
Adjutant-General.
Inspector-General.
Judge-Advocate-General.

Volume II.—Armament, Transportation and Supply:

Quartermaster-General.
Commissary-General.
Surgeon-General.
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Chief of Engineers, Militarv Affairs.
Chief of Ordnance.
Chief Signal Officer.
Chief of Artillery.
Board of Ordnance and Fortification.

Volume III.—Department and Division Commanders:

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Volumes IX–XIII.—Chief of Engineers, River and Harbor Improvements.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX B B B.

TECHNICAL DETAILS OF ENGINEERING METHODS ON FORTIFICATIONS, RIVERS AND HARBORS, AND OTHER WORKS.

FORTIFICATION WORKS.

B B B 1.

DEFENSES OF THE COAST OF MAINE.

[Officer in charge, Maj. S. W. Roessler, Corps of Engineers.]

GENERAL:

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TELEPHONE BOOTHS FOR MORTAR BATTERIES.

The details of the booth are shown on the drawing. Six such booths have been erected and tested during the August maneuvers of 1903.

Local conditions required the booths to be located at variable distances from the pits. At one mortar battery, where the pits are deep, two of them were located at the foot of the rear slope, on the back side of the pits; the other two were located on the natural surface of the ground in rear of the pits and 15 feet above the pit floors. At another

mortar battery, the pits of which are large and open to the rear, the booths were placed on the opposite side of the railroad track.

The fundamental idea of the design was to transmit ballistic data visually. This is done by means of sliding blackboard panels supported in an iron frame, one-half of which projects inside, the other half outside the booth. As shown on the drawing there are five such panels, upon which are written in proper order, beginning at the topmost panel, the several distinct portions of the data, as received over the telephone or telautograph. By using panels instead of a solid board, each bit of information is made available as soon as received.

To make the whole of the panel board visible from every part of a pit, each booth was located off toward one side of the pit, or its walls placed oblique to the rear wall of the battery.

For night service each panel board is illuminated by two electric 16-candlepower lamps with protecting hood and reflector.

As shown, the attempt has been made to give light by day through skylights. These are of doubtful utility and are difficult to make water-tight. I should omit them in future constructions.

The illustration shows two peepholes in one corner of the booth, closed by heavy porthole fixtures on the inside. These openings overlook every portion of the corresponding pit. During drill and target practice a megaphone was placed in one of these openings and the data shouted to the pit as soon as it was received, and thus made available before it could be written on the panel boards. The latter were always used to check the data received through the megaphone.

The walls, floors, and ceilings were strengthened by bars of steel and have developed no cracks during the target practice.

As far as I have learned the booths gave general satisfaction.

POROUS HOLLOW-TILE WALLS AND CEILINGS IN 6-INCH BATTERY.

The walls are 6 inches in thickness and separated by a space of 4 inches from the adjacent mass of concrete. The bricks in the walls are the ordinary 4-duct hollow brick made smooth on the exposed faces and scored only on the mortar faces. The roof is of hollow brick known under the trade name of "Herculean Arch." To guard against possible leakage through the mass of concrete overhead, the roof is covered by a layer of Paroid roofing paper, laid shinglewise, the arch being given a slight slope for drainage.

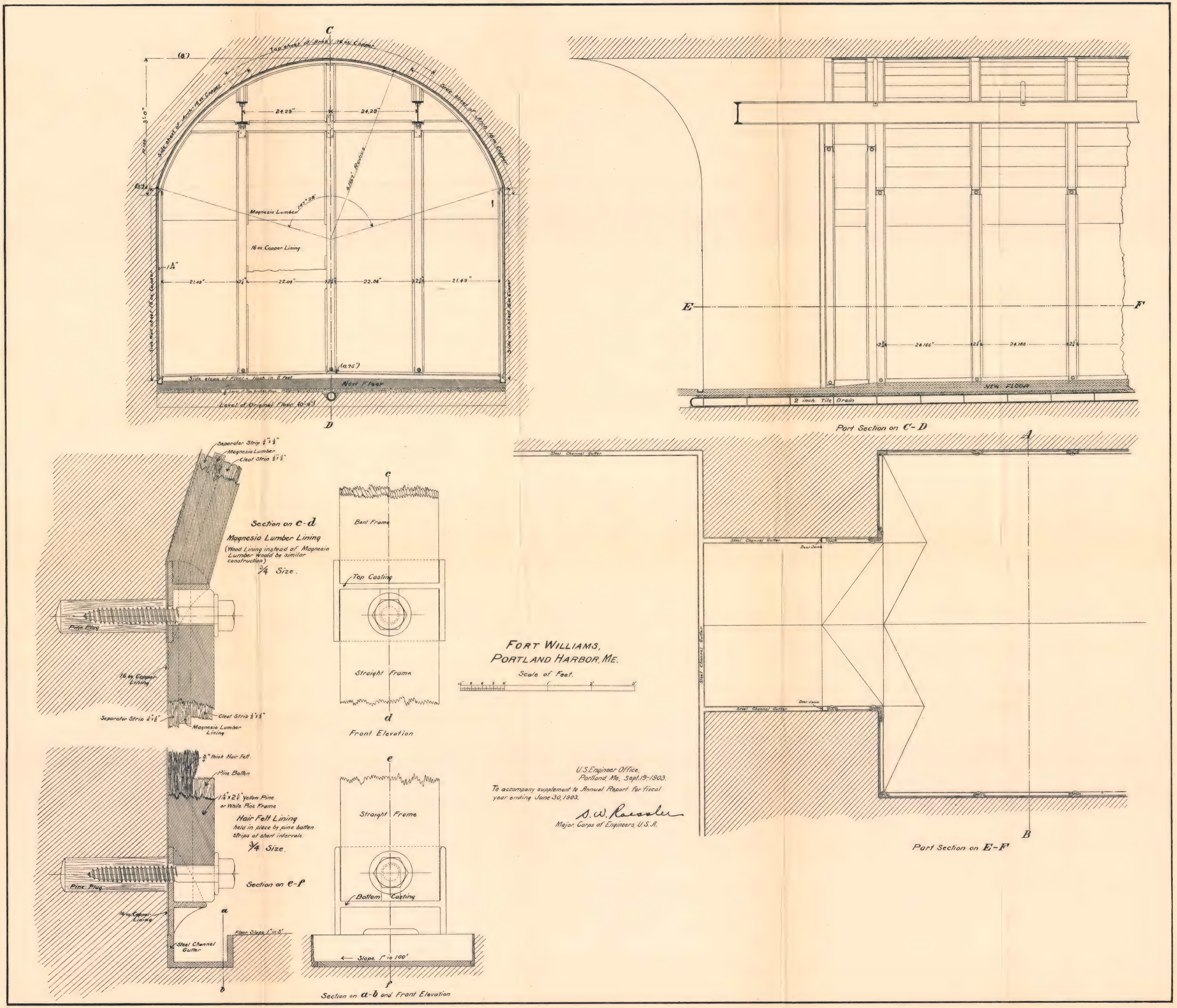
The order of construction was as follows: Concrete walls first; next, the hollow-tile walls; then the herculean arch. The concrete overhead is supported on concrete beams strengthened by twisted steel.

Wherever practicable the 4-inch space around the hollow brick walls and ceilings was made to connect through openings with the outside air. These openings are permanently closed by iron gratings.

In addition to the 4-inch air space above referred to there is a gallery 2 feet wide extending from one flank to the other around and in front of all the rooms of the battery.

There has been no condensation whatever on the walls, but there has been evidence of moisture on the ceiling where the brick were hard-burned and not very porous. The arch brick has to be burned harder than is desirable in order to give it the desired strength, which renders it not so suitable as a lining for magazines as the ordinary hollow porous partition brick. On the whole, however, the ceilings


SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES
MAP OF THE
PRIMARY TRIANGULATION
OF THE
GREAT LAKES
Compiled from readjusted data of the U. S. Lake Survey
under the direction of
Major W. L. FISK, Corps of Engineers, U. S. A.
SCALE OF YARDS
METERS
STATUTE MILES
SCALE 1-1,500,000
SCALE: 1-3000000
1903
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
MINNESOTA
WISCONSIN
MICHIGAN
ILLINOIS
OHIO
PENNSYLVANIA
NEW YORK
ONTARIO
DULUTH
SUPERIOR
MINNEAPOLIS
St. PAUL
CHICAGO
MILWAUKEE
DETROIT
TOLEDO
CLEVELAND
BUFFALO
TORONTO
MONTREAL
SAGINAW
BAY CITY
PORT HURON
KINGSTON
ROCHESTER
THE APOSTLE ISLANDS
ISLE ROYALE
Eng 58 1



C
Top sheet of Arch 16 oz Copper
Side sheet of Arch 16 oz Copper
24.29"
24.29"
Magnesia Lumber
16 oz. Copper Lining
21.49"
22.04"
22.04"
21.49"
(0.75')
New Floor
Level of Original Floor (0'-0")
D
E
F
24.166"
24.166
NEW FLOOR
2 inch Tile Drain
Part Section on C-D
A
Steel Channel Gutter
Door Jamb
Steel Channel Gutter
B
Part Section on E-F
Separator Strip
Magnesia Lumber
Cleat Strip
Section on c-d
Magnesia Lumber Lining
(Wood Lining instead of Magnesia Lumber would be similar construction)
3/4 Size.
Pine Plug
16 oz. Copper Lining
Separator Strip
Cleat Strip
Magnesia Lumber Lining
c
Bent Frame
Top Casting
Straight Frame
d
Front Elevation
FORT WILLIAMS,
PORTLAND HARBOR, ME.
Scale of Feet.
Pine Batten
Yellow Pine or White Pine Frame
Hair Felt Lining
held in place by pine batten strips at short intervals.
3/4 Size.
Section on e-f
Pine Plug
16 oz. Copper Lining
Floor Slope
Steel Channel Gutter
a
b
e
Straight Frame
Bottom Casting
Slope 1" in 100'
f
Section on a-b and Front Elevation
U.S. Engineer Office,
Portland, Me. Sept. 19-1903.
To accompany supplement to Annual Report for fiscal year ending June 30, 1903.
S. W. Roessler
Major, Corps of Engineers, U.S.A.

have been satisfactory, as the number of bricks which have shown condensation is small.

POROUS HOLLOW-TILE LINING OF 3-INCH BATTERY.

This battery has been lined with book tile, medium light in color, smooth on the exposed face. The tiles were placed next the concrete forms and the concrete rammed in back of them.

The lining has not been very satisfactory for two reasons; first, the tile is too hard and the surface too smooth and impervious. As a lining it is much less efficient than the cheaper red hollow partition brick used in a number of other emplacements.

The shape and dimensions of the tile used and the manner in which it was placed are illustrated in the drawing.

LINING USED IN ALL THE ROOMS OF 12-INCH BATTERY.

The lining is illustrated in the drawing herewith. The walls are lined with 2-inch hollow porous brick. The bricks were placed against the forms and the concrete rammed in back of them. The vertical joints are filled with cement mortar, and the bricks were placed in position just ahead of the concrete gang, so that the mortar of the concrete should join with the mortar in the joint and form a tongue of cement which would hold the bricks firmly in place. No other means of holding them against the concrete wall was used. There has been no report received of any bricks similarly supported being loosened in this or in other batteries by target practice.

As shown, the ceiling is a metal lath supported on the lower flanges of the I beams, with a plastering of very porous mortar. The mortar was made in the porportions of 1 barrel of cement to 2 barrels of slaked lime. The surface of the plastering was left as rough and porous as possible. A smooth finish was carefully avoided.

Both the hollow bricks in the walls and the coarse plastering overhead have so far been entirely effective in preventing condensation.

One 12-inch gun emplacement has been similarily lined and has shown no condensation, and a similar lining in one emplacement of a 6-inch battery has been equally satisfactory. Porous hollow tile similar to the above were used both on the walls and ceilings of the rooms in one traverse of one mortar battery, but there has been some condensation at times, though not by any means as much as would have taken place on a less porous surface. Why there should be condensation here and not in other rooms similarly lined is not clear unless the tile used should be too hard burned and not sufficiently porous.

As the age of the battery exercises an influence upon the amount of condensation that may take place, it should be stated that the 12-inch gun emplacements have undergone their second season's test, the 6-inch battery and the mortar battery their third year's test.

COPPER AND WOOD LININGS OF MAGAZINES IN OLD GUN EMPLACEMENTS.

The rooms were habitually wet by leakage. A waterproof lining next the concrete was therefore necessary to collect this leakage. This lining was made of 16-ounce copper, soldered together in the shop into as large sheets as could be conveniently handled, the remain-

ing joints being soldered after the sheets had been placed in position against the concrete walls and arched ceilings.

To prevent condensation a lining of magnesia lumber in one room and of wood in the others was used, the inner lining being supported on strips, the latter being secured to the walls by screw bolts. The details of the lining are shown on the drawing. In designing the lining the idea was to take up as little space as possible, as the rooms were already too small to store the desired amount of ammunition.

Wherever a bolt passed through the copper lining, a washer of felt saturated in melted vaseline was placed next the copper to prevent leakage.

A hair-felt inner lining shown on one of the sketches has not been tried.

The leakage through the concrete has been effectively excluded, but the wood and magnesia lumber do not prevent condensation. As a precaution against condensation this lining is a failure.

Very respectfully, your obedient servant,

S. W. Roessler,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. Army.

B B B 2.

DEFENSES OF PORTSMOUTH, NEW HAMPSHIRE, AND BOSTON, MASSACHUSETTS.

[Officer in charge, Capt. Harry Taylor, Corps of Engineers.]

General:

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During the winter of 1902–3 the magazines in two 8-inch emplacements, thirteen 10-inch emplacements, five 12-inch emplacements, and one mortar battery were lined for the purpose of endeavoring to prevent percolation and condensation. The general method which was followed in this work was to put in a waterproof lining held in place with wood. In the magazines where there was the greatest percolation the waterproof lining was of copper. In others the waterproof lining was of "Paroid" roofing paper, and in others a combination of the two was tried, using copper on the ceiling and "Paroid" on the sides.

In placing the lining in the magazine the general method where copper was used was to place the planks which were to hold the copper ceiling in place on trestles at a convenient height above the floor of the magazine—say, about 4 feet. This formed a platform upon which the copper could be spread and the sheets soldered together, making a perfectly waterproof layer. The copper was also extended down over the sides of the planking about 1 foot. After the soldering was completed the ceiling was jacked up into place by the aid of jacks placed under the wooden planking. It was held in place temporarily by studding, the copper for the sides of the room placed and soldered, the side sheathing planks placed and joists nailed lengthwise of the room to the upper part of the side planking to hold the ceiling in place.

The temporary studding could then be removed, leaving the room clear, only about 2 inches from each side of the room being taken up with the waterproofing. Where "Paroid" was used as a waterproof layer the lining was held in place by means of bolts set in the walls and ceiling. Holes were drilled in about 6 inches, bolts set and grouted in place. Wooden strips 2 by 4 inches were then fastened to the concrete by means of the bolts. The strips which were fastened to the top of the room had a thickness of 2 inches at the center and a slope of 1 inch to the foot toward the sides of the room. The "Paroid" paper was tacked onto the strips in the same manner as shingles are put on, so that there were at least two thicknesses of paper everywhere. Then tongued and grooved pine, cedar, or California redwood was fastened to the strips over the copper, the wooden ceiling supporting and holding in place the "Paroid" paper. Where a combination of the two methods was used the ceiling was worked into place in the same manner as described above where all copper was used. The plank for the entire side of the room was placed in an inclined position, the foot being at the place it was to occupy when finally fitted. The "Paroid" paper was then shingled onto the outside of the planking, the planking tipped up into its place as a whole, and joists nailed lengthwise of the room to support the ceiling in the same manner as where copper was used on the outside. In both methods where copper was used the planking was 2 inches thick. Where the "Paroid" was used the tongued and grooved ceiling was the regular seven-eighths-inch thickness.

It was originally intended to line the inside of the sheathing with nonconducting material and one magazine was lined with magnesia lumber, one with "Transite," which is a material similar to the magnesia lumber, and a third with asbestos millboard. As this work was not completed until late in the spring, and up to that time the results as far as could be observed were quite satisfactory with the wood lining alone, and as the cost of the nonconducting lining was considerable, this lining was omitted from the other magazines.

An experiment was also tried with lining one magazine in which there was no percolation with sheet cork to prevent condensation. In this case the cork was stuck directly to the concrete. It was done under informal agreement with the company that sold the cork, the agreement containing a guaranty that the cork should be fastened to the wall satisfactorily and any that came off within one year was to be replaced by the company without cost to the United States.

In some of the new works which have been built during the past two years the magazines have been lined with a special porous brick, known as "Shawnee" brick, and in another case a battery has been lined throughout with hollow tile of special form.

Observations have been made from time to time throughout the summer of the results obtained by the work above described. In all cases where the copper was used percolation has been absolutely prevented. In two or three cases in which the "Paroid" paper was used it has evidently become punctured and small leaks have developed. These leaks, however, are hardly noticeable. Where the magazines have been kept tightly closed no condensation has been observed, but where the magazine has been opened irregularly or left open all of the time, as has been the case in some of them, there has been considerable condensation upon the wooden linings.

During the month of July, 1903, the weather has been at times extremely hot and the relative humidity has been very high. Inspections have been made particularly to observe the results of the linings, and the results in detail are as follows:

SITE NO. 1.

Inspection made July 6, 1903. The magazines in these emplacements have copper on the ceiling and "Paroid" on the walls.

Magazine No. 1.—No dampness in this room, but there was evidence that water had at some time come in under the lining of the walls. There was no evidence of any leak of walls or ceiling. The walls and ceiling felt dry. The door was closed and locked. The adjacent rooms were damp with water on the floors and condensation on the walls.

Magazines Nos. 2 and 3.—The magazines felt cool and damp. Walls and ceilings damp. A film of water covered more than one-half of the floor surface. No evidence of leakage in the walls and ceilings. Water evidently came in under the side lining. Doors were closed. Adjacent rooms were damp, with more or less water on the floors.

SITE NO. 2.

Inspection made July 6, 1903. Magazines have copper on the ceiling and "Paroid" paper on the walls.

Magazine No. 1.—The room was cool and damp. A film of water covered the whole floor surface. The ceiling and walls were damp. The door of the magazine was open, and it was reported that it had been kept open. Adjacent rooms were damp.

Magazine No. 2.—Magazine was dry. The ceiling and walls felt dry and warm. There was no evidence of any water in the room or having been in the room. The doors of the magazine were closed and had been kept closed. There was a quantity of powder stored in the room. The adjacent rooms were cool and damp.

SITE NO. 3.

Inspection made July 10, 1903.

Magazine No. 1.—Lining of 16-ounce copper held in place by planking, a floor of hard pine, two thicknesses, seven-eighths inch each, with an asbestos millboard layer between the two thicknesses. Walls and ceiling of room dripping with condensation. Door of magazine and outside doors of emplacements open. Rooms and galleries in the vicinity of the magazine were dripping with condensation. Water was standing in shallow pools on the floors.

Magazine No. 2.—Lining and floor the same as magazine No. 1, with the addition of a lining of magnesia lumber on walls and ceiling inside of the planking. No condensation was visible in this room, except on the electric-light fittings. The door of the magazine was open, the outside door closed. Rooms and passages in the vicinity of the magazine dripping with condensation and floors very wet.

Magazine No. 3.—Lining and floor the same as No. 2, except that the "Transite" was used in place of magnesia lumber for the inside lining. The door of the magazine was closed; outside doors closed. This room

was perfectly dry. It had not been used by the artillery, and cement for certain work in progress by the Engineer Department in the vicinity of the battery had been stored in the magazine for some time. Cobwebs in various parts of the room were plainly marked by cement dust which had settled on them. There was no condensation visible anywhere and no signs of there having been any at any time during the summer.

Magazine No. 4.—Lining and floor the same as No. 3, except that asbestos millboard was used in place of the "Transite" for the inside lining. The millboard felt damp and had swollen some, indicating that it had absorbed moisture, but there was no moisture standing anywhere in the room, except a little condensation on the electric-light fittings. Door of the magazine was closed, outside doors in the vicinity closed. Rooms and passages in the vicinity dripping with condensation.

Magazine in single 10-inch emplacement.—Lining of "Paroid" paper held in place by planking. In this magazine the "Paroid" paper was applied in the same manner as the copper in the other magazines, not as the "Paroid" paper was in the other magazines as described in the general statement above. The magazine was dripping with condensation and the planking appeared discolored and swollen from the effects of the water condensed upon it. Condensation was much worse in this magazine than in any other lined magazine. It is believed that this is partly due to the fact that this magazine is surrounded by a heavier mass of concrete than any other. The outside door of the passage leading to the magazine was closed, but the door to the magazine was open. All of the rooms and passages in the vicinity of the magazine were dripping with condensation, and the floors were covered with water, which stood in shallow pools.

At the time the inspection was made at this fort the thermometer was in the vicinity of 95°. A tremendous difference in temperature was noticed in passing from the outer air into the magazines, especially into that in the single 10-inch emplacement. It felt as though there was at least 40 or 50° difference in temperature between the outside air and the air in this battery. An inspection of the magazines at this fort was made again on July 30, 1903. On the latter date the temperature was not quite as high as it was at the date of the first inspection and the amount of condensation was not quite as great, but the general conditions were practically the same as reported above, only in a lesser degree.

SITE NO. 4.

Inspection made July 30, 1903. All of the magazines in these emplacements are lined with copper, held in place with planking, and have double-thickness wood floors, but have no lining inside of the planking.

Magazine No. 1.—The walls and ceiling felt cool and more or less damp, and there was a little condensation noticeable, but not much. The door of this magazine has been kept closed throughout the summer, but the outside door of the passage has, as a rule, been left open. The rooms and passages in the vicinity of this magazine were dripping with condensation and percolation.

Magazine No. 2.—The ceiling and walls of this room were gener-

ally fairly dry, but a streak of condensation on the ceiling the width of the door extended from the door across the length of the room and part way down the end wall. A close examination indicated that there was an opening about one-half inch wide between the door and the lintel, and apparently the warm air from the outside passed over the door, crossed the room, passed down the end of the room, and crossed the floor out under the door. Moisture was deposited from this warm current of air as it passed along the ceiling until it reached the wall at the end of the magazine opposite the door, by which time the moisture had been nearly all extracted from it. The condensation on the end wall gradually decreased from the top until near the floor it disappeared. In the magazine were a number of charges of powder in metal cases. Those cases which were piled immediately in front of the door under the damp streak on the ceiling were covered with condensation, while on those that were piled up at one side of the room no condensation was visible. The door of this magazine has been kept closed, but the outside doors have been generally left open. Rooms and passages in the vicinity of this magazine were dripping with condensation and percolation.

Magazine No. 3.—This magazine was warm and dry, and the plank lining appeared bright and without the slightest sign of discoloration, indicating that there has been no condensation in the room at any time during the summer. The door of this magazine has been kept closed. In the passageway in its vicinity was stored a miscellaneous assortment of paint, brushes, etc., belonging to the artillery, and all the doors in the vicinity had been kept closed and locked at all times during the summer. There was some condensation in the rooms and passages in the vicinity of the magazine, but not nearly to the same extent as in the others in this battery.

Magazine No. 4.—Magazine felt cool, but there was no condensation visible on the walls or ceiling, but there was a little discoloration of the planking, indicating that there had been some condensation. During the short time that the magazine was opened for the inspection condensation began to appear upon the electric-light fittings, where there was none when the magazine was first entered. The door of this magazine has been kept closed, but the outer doors have been part of the time opened and part of the time closed.

Magazine No. 5.—The conditions here were practically the same as in magazine No. 4. Condensation was visible on the knots, and pitchy, hard places on the planking.

SITE NO. 5.

Inspection made July 10, 1903. One magazine in the old mortar battery lined with "Paroid" paper held in place with tongued and grooved sheathing. No wooden floor was laid in this magazine. Condensation appeared in spots, but was not very heavy. The sheathing had swollen in some places, indicating that it had absorbed considerable water. The door of the magazine was closed at the time of the inspection, but had been left open a considerable part of the time during the summer. The passageways in the vicinity of the magazine were open to the weather, being without doors, and these were dripping with condensation.

SITE NO. 6.

Inspection made July 30, 1903. Two magazines lined with "Paroid" paper, tongued and grooved sheathing, with double-thickness wooden floors. Magazines were fairly dry. Evidences of slight condensation were visible. The floors had noticeably swollen. By lifting up a trap left in floor for the purpose of getting at the drains considerable water could be seen under one of the floors running into the drain, indicating percolation through the concrete on to the waterproof layer. In the other magazine no water was visible under the floor. The doors of the magazines were closed and locked. The doors of the outside rooms and passages were closed. Considerable condensation in the outside rooms and passages.

SITE NO. 7.

Inspection made August 5, 1903. Three magazines lined with "Paroid" paper, tongued and grooved sheathing, and double thickness wooden floors. The sheathing in two of the magazines is hard pine and in the third of cedar. Other conditions are identical.

In the magazines lined with hard pine the lining was covered with mold, indicating condensation. In the magazine lined with cedar the lining was as bright as when first put in, showing that there had been no condensation in this magazine at any time during the summer. In this magazine the door frames were of hard pine, and these were covered with mold the same as the lining in the other two magazines. The doors of the magazines were closed. The outside doors were closed at time of inspection, but not locked.

SITE NO. 8.

Inspection made August 4, 1903. One magazine lined with sheet cork stuck directly to the wall. Considerable of the cork lining has come off and the company is taking steps to replace it. The cork was stuck to the walls with a special preparation of asphaltum. That which has come off appears as if the asphaltum was allowed to cool before the cork was firmly in place, but sheets of cork are now coming off which two months ago were apparently well fastened. There was no percolation in this battery. The cork lining was covered with condensation, was moldy, and much discolored. The door of the magazine was open, outside passage doors closed. Other rooms and passages in the vicinity of the magazine were covered with condensation. In another magazine in this same battery the conditions were identical with the one which was lined with cork except that there was no lining in it. The door of this magazine has been kept closed and locked all summer, probably not having been opened at all before the inspection was made. This magazine was perfectly dry and there were no evidences of condensation having taken place in it at any time during the summer. The gallery immediately outside of the door of this magazine was quite wet with condensation, but the balance of the rooms and passages of this emplacement were dry.

SITE NO. 9.

The emplacements at this locality are lined throughout with a special form of hollow book tile. The floors of the rooms slope from the center to the sides, and around the sides of every room are gutters

at least 3 inches wide and 2 or more inches deep. The tile are placed so that the hollows are on end, and the gutter in the rooms extends under the tiling so that the air has access to hollows in the tile, and precautions were taken to insure the air spaces of the tile on the sides of the rooms having connection with the air space of the tile of the ceiling.

The construction of these emplacements is not quite completed and has been in progress during the summer. Workmen have been passing in and out of the rooms as often as necessary and no special precautions have been taken to keep the doors closed. In the early spring during one unseasonably hot spell, when the relative humidity was high, slight condensation was noticed on a few of the hardest burned tile, but at no other time has there been the slightest sign of condensation anywhere in the battery and there has never been a drop of percolation. In other words, up to the present time this battery is perfectly dry, both as regards percolation and condensation.

NEW MORTAR BATTERY AT SITE NO. 5.

The magazines in this battery were lined with a porous brick known as "Shawnee" brick. This brick is a light buff color and absorbs water like blotting paper. No condensation has been noticed on the walls or ceilings of the magazines which have this lining. The doors of these rooms have not yet been placed. On one occasion, viz, July 30, 1903, when the inspection was made, the direction of the wind was such that a very noticeable current of air circulated through the magazines. In the other parts of the battery where there was no brick lining there was more or less condensation. The floors of the magazine were also quite damp.

The magazines for two 6-inch emplacements at this locality and two 6-inch emplacements at site No. 8 have also been lined with this "Shawnee" brick. No condensation has been observed on the brick in these emplacements. Wherever mortar shows between the bricks and around the electric-light fixtures condensation has been observed at various times.

The conclusions to be drawn from the experiments and observations detailed above are that it is perfectly possible to prevent water percolating the concrete from entering the magazines, and that condensation may be prevented if the doors are kept closed during condensing weather, but if the doors are not kept closed condensation must be expected; the magazines lined with "Transite" and "Magnesia lumber" are freer from condensation than those in which wood alone is used; book tiling placed as described is fairly free from condensation and "Shawnee" brick apparently entirely free. Of all the linings experimented with, "Shawnee" brick appears to be the best for use in new batteries; it is, however, the most expensive method of lining of all those described.

A general summary of the cost of lining the magazines in Boston Harbor in detail and an itemized cost of lining each magazine is as follows:

SITE NO. 3.

These magazines (four) were lined with 16-ounce copper and 2-inch hard-pine planks.

Double floors were laid of seventh-eighths inch hard-pine flooring, with one-fourth inch asbestos mill board between.

	Magazine No. 1.	Magazine No. 2.	Magazine No. 3.	Magazine No. 4.
Walls and ceiling:				
Lumber	$75.58	$59.66	$87.52	$79.56
Magnesia building lumber		153.50		
Transite board			132.00	
Asbestos mill board				40.00
Nails and gasoline	4.65	4.38	8.55	8.30
Carpenters	85.07	97.16	98.75	110.71
Copper	112.55	135.86	196.83	184.76
Solder, acid, and rent of brake machine	8.55	8.17	16.84	16.64
Coppersmiths and helper	87.25	68.89	101.02	91.84
Total	373.65	527.62	641.51	531.81
Double floors:				
Lumber	20.77	20.77	41.53	38.03
Asbestos	4.81	4.82	9.63	8.82
Nails and gasoline	2.20	2.00	7.00	6.00
Carbolineum	4.81	4.82	9.63	8.82
Carpenters	15.30	16.61	18.36	17.55
Total	47.89	49.02	86.15	79.22
Total for walls, ceiling, and floors	421.54	576.64	727.66	611.03

The magazine of the single 10-inch emplacement was lined with "Paroid" paper (two layers) and seven-eighths-inch redwood sheathing.

Double floors were laid of seven-eighths-inch hard-pine flooring, with one-fourth inch asbestos mill board between.

Walls and ceiling:	
Paroid paper	$15.00
Parine cement	12.15
Lumber	65.15
Nails and gasoline	4.75
Carpenters (labor)	76.82
Total	173.87
Double floors:	
Lumber	20.99
Asbestos	4.75
Nails and gasoline	3.00
Carbolineum	4.80
Carpenters	17.00
	50.54
Total for walls, ceiling, and double floor	224.41

SITE NO. 4.

These magazines (five) were lined with 12-ounce copper and 2-inch hard-pine planks.

Double floors were laid of seven-eighths-inch flooring, with one-fourth inch asbestos mill board between.

	Magazine No. 1.	Magazine No. 2.	Magazine No. 3.	Magazine No. 4.	Magazine No. 5.
Walls, ceiling, and floor:					
Lumber	$70.25	$70.25	$70.25	$81.60	$81.60
Asbestos	4.92	4.93	4.93	9.31	9.31
Carbolineum	6.90	6.90	6.90	12.14	12.15
Nails and gasoline	2.29	2.29	2.29	4.28	4.28
Carpenters (labor)	52.85	56.04	37.16	48.23	56.06
Copper	116.03	116.02	116.03	133.20	133.21
Solder and acid	6.94	6.94	6.94	7.47	7.46
Coppersmiths and helper (labor)	78.38	86.12	81.25	91.00	69.25
Total	338.56	349.49	325.75	387.23	373.32

SITE NO. 5.

This magazine was lined with "Paroid" paper (two layers) and seven-eighths-inch redwood sheathing.

No wood floors were laid, as the concrete pavement had just been taken up and relaid.

Walls and ceiling:	
Bolts	$8.75
Drilling for and setting bolts (labor)	110.57
Paroid paper	75.00
Parine cement	6.50
Carbolineum	12.50
Lumber	284.75
Nails and gasoline	8.50
Carpenters (labor)	112.32
Total	618.89

SITE NO. 6.

These magazines (two) were lined with Paroid paper (two layers) and seven-eighths-inch redwood sheathing.

Double floors were laid of seven-eighths-inch hard-pine flooring, with one-fourth-inch asbestos millboard between.

	Magazine No. 1.	Magazine No. 2.
Walls and ceiling:		
Bolts	$5.39	$5.38
Drilling for and setting bolts (labor)	155.60	140.67
Paroid paper	37.50	37.50
Parine cement	6.92	6.92
Lumber	135.62	135.63
Nails and gasoline	6.36	6.36
Carpenters (labor)	88.10	67.28
Total	435.49	399.74
Double floors:		
Lumber	84.33	84.32
Asbestos	15.24	15.24
Nails and gasoline	3.00	3.00
Carpenters (labor)	41.00	41.00
Total	143.57	143.56
Total for walls, ceiling, and floor	579.06	543.30

SITE NO. 7.

These magazines were lined with Paroid paper (two layers) and seven-eighths-inch sheathing.

Double floors were laid of seven-eighths-inch flooring, with one-fourth-inch asbestos millboard between.

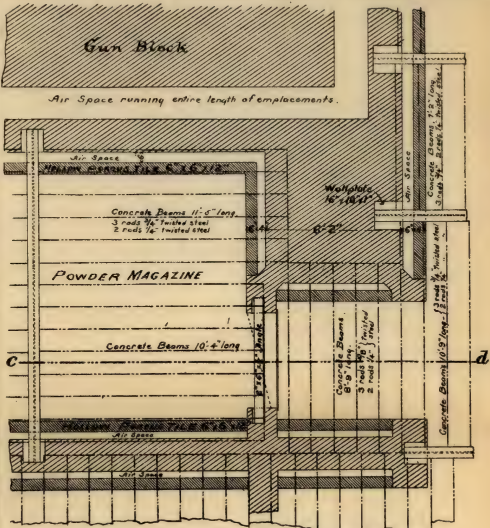


Fig. 1. Part Plan showing arrangement of Concrete Beams.

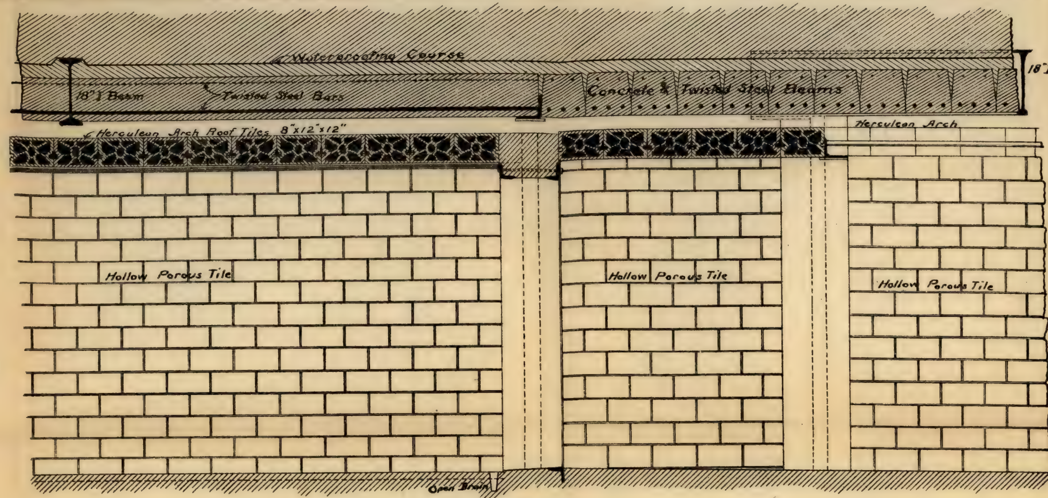


Fig. 2. Section on c-d (Fig. 1)

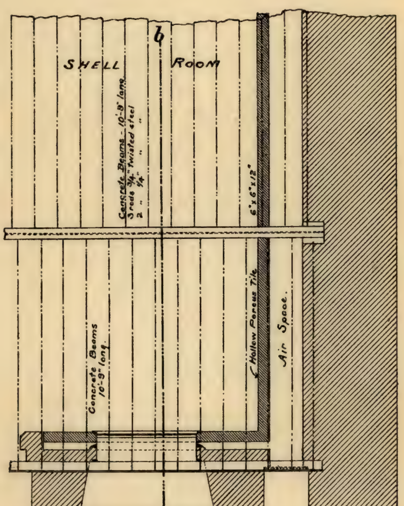


Fig. 3. Part Plan showing arrangement of Concrete Beams.

Scale; of feet.

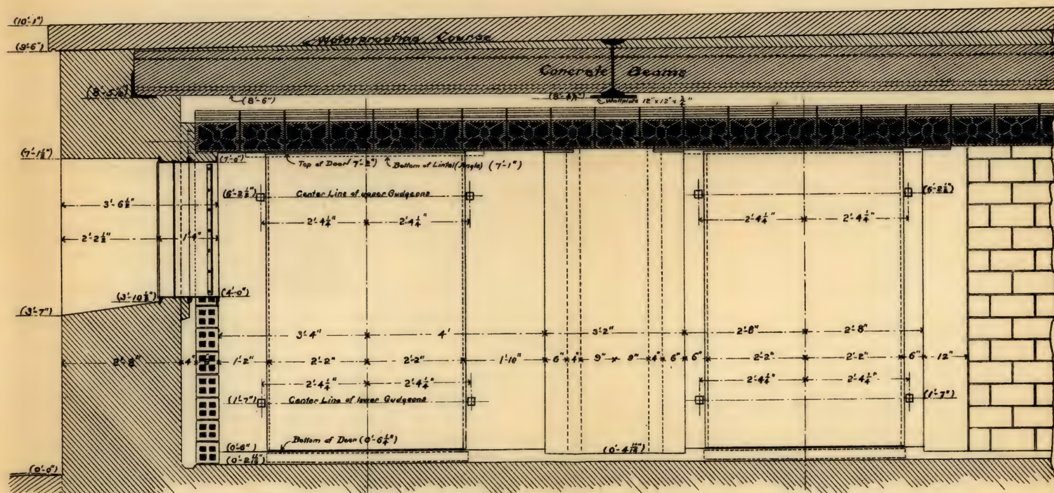


Fig. 4. Section on a-b (Fig. 3)

Scale of feet.

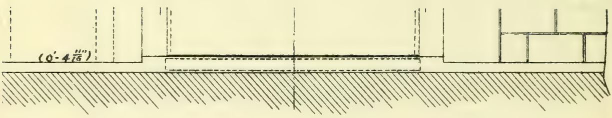
SIX INCH BATTERY.

PORTLAND HARBOR, ME.

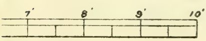
U.S. Engineer Office.
Portland, Me., Sept 19, 1903.
To accompany supplement to Annual Report for fiscal year ending June 30, 1903.
S. W. Roessler
Major, Corps of Engineers, U.S.A.

ANDREW B. GRAHAM PHOTO-LITHO. WASHINGTON, D.C.

Drawn by C.C. Manning.



b (Fig. 3)



U.S. Engineer Office,
Portland, Me., Sept 19, 1903.
plement to Annual Report for fiscal year ending June 30, 1903.

S.W. Roessler
Major, Corps of Engineers, U.S.A.

Drawn by C.C. Manning, Surveyman.

	Magazine No. 1.	Magazine No. 2.	Magazine No. 3.
Walls and ceiling:			
Bolts	$7.89	$7.89	$7.89
Drilling for and setting bolts (labor)	115.00	101.33	75.67
Paroid paper	37.50	37.50	37.50
Parine cement	4.32	4.32	4.32
Lumber	121.56	121.56	121.57
Nails and gasoline	6.86	6.86	6.86
Carpenters (labor)	98.39	96.45	91.61
Total	391.52	375.91	345.42
Double floors:			
Lumber	74.74	74.74	74.74
Asbestos	9.65	9.65	9.65
Nails and gasoline	3.43	3.43	3.43
Carpenters (labor)	43.54	47.48	48.06
Total	131.36	135.30	135.88
Total for walls, ceiling, and floor	522.88	511.21	481.30

Area of walls and ceiling covered for each magazine, 1,352 square feet.
Area of double floors covered for each magazine, 526 square feet.

GENERAL STATEMENT OF COST OF LINING MAGAZINES, BOSTON HARBOR, MASS., WINTER OF 1902–3.

The following magazines were lined with 2 by 4 inch strips bolted to walls and ceilings, 2 by 4 inch foundation for floors, two layers of Paroid paper, seven-eighths-inch sheathing, and double floors of seven-eighths-inch hard pine and asbestos:

	Walls and ceiling.			Double floors.			Cost of walls, ceilings, and double floors.	Area of floor.	Cost per square foot of floor.
	Cost.	Area covered.	Cost per square foot.	Cost.	Area covered.	Cost per square foot.			
Site No. 7:		*Sq. ft.*			*Sq. ft.*			*Sq. ft.*	
Magazine No. 1	$391.52	1,352	$0.2896	$131.36	526	$0.2497	$522.88	526	$0.9940
Magazine No. 2	375.91	1,352	.2780	135.30	526	.2572	511.21	526	.9719
Magazine No. 3	315.42	1,352	.2555	135.88	526	.2583	481.30	526	.9150
Site No. 3: Magazine	173.87	529	.3287	50.54	160	.3159	224.41	160	1.4025
Site No. 6:									
Magazine No. 1	435.49	1,394	.3124	143.57	552	.2601	579.06	552	1.0490
Magazine No. 2	399.74	1,394	.2867	143.56	552	.2601	543.30	552	.9842
Site No. 5: Magazine	618.89	2,469	.2507	(a)	(a)	(a)	....	....	....

a Not laid.

The following magazines were lined with 12-ounce copper, 2-inch hard pine, double floor of seven-eighths-inch hard pine and asbestos:

	Cost of walls, ceilings, and double floors.	Area of floor.	Cost per square foot of floor.
Site No. 4:		*Sq. ft.*	
Magazine No. 1	$338.56	220	$1.5389
Magazine No. 2	349.49	220	1.5882
Magazine No. 3	325.75	220	1.4807
Magazine No. 4	387.23	270	1.4342
Magazine No. 5	373.32	270	1.3826

The following magazines were lined with 16-ounce copper, 2-inch hard pine, double floor of seven-eighths-inch hard pine and asbestos:

	Walls and ceilings.			Double floors.			Cost of walls, ceilings, and double floors.	Area of floor.	Cost per square foot of floor.
	Cost.	Area covered.	Cost per square foot.	Cost.	Area covered.	Cost per square foot.			
Site No. 3:		*Sq. ft.*			*Sq. ft.*			*Sq. ft.*	
Magazine No. 1	$373.65	570	$0.6555	$47.89	220	$0.2177	$421.54	220	$1.9161
Magazine No. 2	374.12	688	.5438	49.02	220	.2228	[a]423.14	220	1.9232
Magazine No. 3	509.51	997	.5110	86.15	314	.2744	[a]595.66	314	1.8968
Magazine No. 4	491.81	936	.5254	79.22	293	.2704	[a]571.03	293	1.9489

[a] Exclusive of cost of lining inside of wood.

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 3.

DEFENSES OF NARRAGANSETT BAY, RHODE ISLAND.

[Officers in charge, Maj. G. W. Goethals and Capt. C. E. Gillette, Corps of Engineers.]

GENERAL:

* * * * * * *

PREPARATION OF FOUNDATION FOR A 3-INCH BATTERY.

The 3-inch gun battery is located on low ground, the surface being a few feet only above high tide. A test pit, sunk at the proposed site, showed 4 feet of very fine sand above the water line, followed by 3 feet of saturated sand, ordinarily designated as quicksand. The total depth of the test pit was 20 feet, the remaining 13 feet being a bog composed of soft, saturated mud mixed with decayed moss and other vegetable matter. The nature of the underlying material having been ascertained, a second pit was excavated 4 feet deep, to the surface of the saturated sand. In the latter a 12 by 12 inch timber was placed on end and loaded with 2,000 pounds, including the weight of the timber. Under this condition of loading frequent observations were taken with a level, and a total settlement of one-eighth of an inch noted. When the settlement was no longer appreciable the load was increased to 2,500 pounds, and a further settlement of one-fourth of an inch took place, making a total of three-eighths of an inch. The maximum load to be sustained by the foundation is 1,900 pounds per square foot over a comparatively small area where the concrete extends in a solid mass from the foundation to the superior slope. For a greater portion of the battery the load is 1,500 pounds or less per square foot. In preparing the foundation a sufficient area was excavated to provide for a uniformly distributed load of 1,600 pounds per square foot, the area required being approximately 3

feet larger in length and breadth than the area actually occupied by the base of the battery. The site was excavated to within 6 inches of the saturated sand and entirely surrounded with double-lapped sheet piling, driven to a depth of 10 feet. The object of the sheet piling is to prevent the underlying semiliquid material from spreading should trenches or other excavations be made near the battery at a future date. The entire excavated area was covered with 18 inches of stone, broken, taken from the excavation for another battery in the vicinity, and ranging in size from one-half of a cubic foot down, the whole being well rammed into place. A 6-inch layer of concrete was placed on top of the broken stone, with pieces of old railroad iron laid in the concrete in such a manner as to distribute the loading uniformly, or practically so. The top of the sheet piling was cut off level with the surface of the concrete foundation. No subdrainage was provided and the drainage of the battery, through the air spaces, has been kept above the foundation. The battery has been practically completed, waiting for guns only, for the past three months, and to the present time there has been no settlement and no cracks are apparent. The foundation, including sheet piling, broken stone, and concrete in place, cost 41 cents per square foot of area covered.

LINING FOR MAGAZINES.

Magnesia lumber.—In compliance with instructions issued by the Chief of Engineers in an indorsement dated July 30, 1902, on a letter from Col. Peter C. Hains, Corps of Engineers, of July 22, 1902, one of the magazines of a mortar battery has been lined with magnesia lumber as an experiment. The room was thoroughly dried and the side walls cleaned with steel brushes; a heavy coat of bitumen and tar was then applied and thoroughly rubbed in. A second coat was also applied to the walls for a distance of 2 feet from the floor. The walls were marked and drilled for inserting wooden plugs for fastening the lining. Two thicknesses of tarred paper, well lapped, were placed between the wall and the magnesia boards, and the whole securely fastened by five 1½-inch brass screws to each sheet of magnesia lumber, the sheets being 3 feet 9 inches by 3 feet 9 inches in size. On the ceiling a wooden framework was fastened to the angle irons supporting the sheet-copper roof, and the magnesia lumber fastened to the framework with 1¼-inch copper tacks. After completion the magnesia lumber was painted with two coats of "Gypsine," followed by one coat of "cold-water paint." The floors were relaid with concrete and given ample pitch toward the drains. Before the lining was put in the magazine was dripping wet at times; subsequently there has been no condensation, the magazine being perfectly dry, with the exception of a slight indication of moisture near the bottom of the wall toward the heavy mass of concrete. Here under favorable atmospheric conditions a portion of the lining, about 5 inches square in area, is slightly discolored and feels damp; no moisture, however, appears on the surface. On the whole, the condition of the magazine is greatly improved and the result satisfactory.

Compressed cork.—A second magazine of the same battery has been lined with compressed-cork board as an experiment, and by direction of the Chief of Engineers, indorsement of September 11, 1902, on letter from Capt. Harry Taylor, Corps of Engineers, dated August 13,

1902. This magazine was treated and lined in the same manner as the magazine described above, except that cork boards were used instead of magnesia lumber, and the cork was painted with three coats of "cold-water paint." The cork boards were 9 by 36 inches by one-fourth inch and were put on in vertical strips, the longer sides being vertical. The cork lining has proven very unsatisfactory; the sheets sag out or bulge between the fastenings, leaving in some instances an open joint. This may be rectified by fastening half-round wooden molding over the joints. In addition, however, the cork has molded, having a fungous growth in many places and brown blotches in others, so that the surface presents a mottled, unsightly appearance, accompanied by an extremely disagreeable odor. The molding is manifestly due to an ingredient of the "cold-water paint," as wooden strips and terra-cotta tiles that were painted with it have molded similar to the cork. During periods of excessive humidity the "cold-water paint" has an offensive odor like that of sizing, and it has not given satisfactory results under any of the various conditions to which it has been subjected in this district.

Linings in general.—During the past year, in addition to the linings described above, book tiles and white absorbent bricks have been used. The book tiles are 12 by 18 inches, and it is impossible to lay them in the walls neatly because a large proportion of them are warped and irregular in size. Condensation has taken place on them at times, and in many cases the tiles have become discolored from dampness in the adjacent concrete. The most satisfactory lining used is the white bricks. The bricks are regular in size and color and may be laid neatly, with one-eighth-inch joints or less, by using a mixture of lime and cement mortar. The bricks have shown no condensation as yet and have retained a uniform color. In all side walls the white brick has been backed up with one course of common brick, and in case of walls 2 feet or less thick the entire wall is built of brick.

Cost of lining in place.

	Per sq. foot.
Cork boards, 9 by 36 inches by one-fourth inch	$0.19
Magnesia boards, 3 feet 9 inches by 3 feet 9 inches by one-fourth inch	.29
Book tiles, 12 by 18 by 3 inches	.27
White brick, backed by one course common brick, 8-inch wall	.33
White brick, backed by three courses common brick, 18-inch wall	.55
White brick, backed by five courses common brick, 24-inch wall	.76

In the above statement the cost of concrete saved by using brick has been deducted in obtaining the cost per square foot of brick lining. The white brick cost $46.50 per thousand laid in place, and the common brick $25.50.

Painting concrete.—Having experienced some difficulty in making paint adhere to the concrete of the superior slopes, the following method of painting has been adopted, and has resulted so far in a coating that is adhesive and also retains a uniform color, somewhat lighter, however, than when applied. The superior slopes of all recently constructed batteries have been carefully troweled so as to produce a hard smooth surface similar to granolithic sidewalks. Immediately before the paint is to be applied the concrete is given two coats of the Sylvester process, applied as follows: The concrete surface being dry, a soap wash, composed of three-fourths of a pound of Castile soap shaved and dissolved in 1 gallon of water, is applied at boiling heat,

with a flat brush, care being exercised not to produce a froth. After allowing twenty-four hours for the above to dry, a coating of one-half a pound of alum dissolved in four gallons of water is applied in like manner, except that the temperature of the latter should be between 60° and 70°. Second coats of soap and alum are similarly applied at 24-hour intervals. For painting, asbestos green paint was used. The paint is strained and mixed with neat cement and in small quantities as needed, the proportions being 1 quart of cement to 1 gallon of paint. The mixture must be thoroughly stirred in the beginning, also during use, to prevent the cement from settling. Two coats of the paint and cement mixture were laid on and well rubbed in with a large flat brush. The cement seems to act as a binder, at the same time giving body to the paint and absorbing the excess of oil, which in several instances where applied alone seems to have been injurious to the concrete finish.

Very respectfully,

CASSIUS E. GILLETTE,
Captain of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 4.

DEFENSES AT EASTERN ENTRANCE TO LONG ISLAND SOUND.

[Officer in charge, Maj. C. F. Powell, Corps of Engineers.]

GENERAL:

* * * * * * *

DAMP PROOFING.

Previous to the present year the method applied in most cases for prevention of percolation of water from overhead into magazines and other principal rooms was to lay in the concrete mass 1 foot to 3 feet above ceilings a suitably inclined waterproof course of two thicknesses of 2-ply tarred roofing paper in coatings of coal-tar product; the courses terminate at 4-inch blind or inclosed air spaces; draining provision was made at the bottom of the air spaces. The coal-tar coating was Gilbreth's waterproof cement.

The concrete surface for the waterproof course was smoothed with mortar and received a brush coat of the waterproof cement applied hot, then in turn a layer of the roofing paper, hot cement, a second layer of the paper, breaking joints with the first, and a last coat of the waterproof cement. The damp-proof layer extended a little beyond the top of the air space and to two courses of brick laid loosely so as to allow the water to flow freely through joints of the brick into the air space at its farther side.

At a magazine where this method was used small leakage appears during breaking up of winter and early rains of spring at the lower half of a wall, perhaps due to defective drainage of the blind air space; at two other cases leaks under the damp-proof course occurred, one of which was effectually remedied, as the cause and place of the leak were found.

So far the method of damp proofing has on the whole answered its purpose. Objectionable features of the method are, it is believed, the breaking of the continuity of the concrete by a layer of foreign material and carrying water into an air space, especially an inaccessible one.

Loading platforms over rooms or passageways were generally faced with thin coats of asphalt or a coal-tar product, which became broken or worn out and permitted leaks. In one case a damp-proof course, about as above described, but terminating differently, was laid near the top of a loading platform, the surfacing of cement mortar averaging only about 1 inch thick. The surfacing became badly cracked and loosened wherever the sun's rays fell upon it. Parts in the shade are still in good condition. The broken or cracked blocks were replaced by new work of steel-concrete blocks, laid with wide joints, which were filled with Webster's elastic cement. The new work appears promising, but is not old enough to show if it be durable. Loading platforms at another battery were covered with an asphalt pavement laid immediately on the concrete. This pavement cracked badly along the joints of the concrete and irregularly at other places and permitted leaks in rooms underneath. Filling the cracks with similar material and rolling the filling, as has been done from time to time, was not satisfactory. Ironing the filling and over new cracks with a hot smoothing iron occasionally during cold weather has proven a better temporary remedy.

The concrete roof of a mining casemate and under the earth cover was paved with sheet asphalt 1 inch thick. The pavement leads to broken stone filling against the outer side walls, at the bottom of which porous tile drains were laid for carrying the water away. There has been no leakage at the casemate.

At a battery where no damp-proof course was laid one magazine was lined with galvanized sheet iron and the other with concrete slabs at the ceiling and hollow tile at the walls. The slabs are suspended by means of brass bolts passing through sheet-lead collars. The tops of the slabs were painted with asphalt and the transverse joints covered with strips of sheet lead. These interior linings, now about 3 years old, are intact and prevent leakage in the rooms. Water dropping on the false ceiling runs to the sides, where it falls in gutters cut in the floor and thence is carried to drains.

At a mortar battery finished last year floors are damp proofed by means of tarred roofing paper and good underdrainage.

At all emplacements under construction this year the damp-proof course is sheet copper having soldered and double-locked joints, laid on top of the concrete, under the earth cover, and over air spaces and the damp proofing at the outside face of the concrete. This face is made reasonably tight during construction and afterwards, when dry and warm, is coated with hot waterproof coal-tar cement, against which a vertical layer of porous partition tile is at once placed and backed with clean gravel or broken stone and then the earth parapet. Porous drain tile is laid at the base of the concrete face. The outside of walls not inclosing rooms or passages, but having exposed faces, is coated with the hot coal-tar cement to prevent discoloration of the inside faces. Floors are damp proofed underneath with two layers of tarred felt or three of roofing asbestos and drainage at the subgrade provided in cases of any probable need.

REDUCTION OF CONDENSATION.

The 4-inch blind air space named above, and which was also built in at the battery where there was no damp-proof course, does not seem to appreciably lessen condensation. The air-space partition wall is of concrete and, except at one battery, is 24 inches thick; at the excepted battery the partition wall is 15 inches thick. At the mortar battery finished last year ceilings are made with flat arch hollow tile 6 inches in depth, resting on and inclosing the lower flange of the **I** beams. The ceilings are thinly plastered. It is judged that condensation at these ceilings is much reduced by the hollow tile.

At a 3-inch battery built last year the air spaces inclosing magazine are 18 inches wide and open to the rear, where gratings and storm doors are provided. The partition wall is 12 inches thick and made of porous brick; the air spaces receive drainage. Sufficient of the brick were heated, and before cooling their sides and ends to be placed at the air space in laying were dipped in hot waterproof cement. The ceilings at this battery are lined with Herculean flat-arch tile resting on top of the side air-space partition walls; the ends of the through tile openings at the air spaces of one magazine were closed and at the other open. The former case gives less condensation at ceilings than the latter. It is intended to close the ends of these tile openings at the air spaces. Similar 18-inch air spaces are being built at two new 6-inch batteries.

At other rapid-fire batteries under construction interior porous brick linings, 4 inches thick and built against the concrete when that is laid or attached to it by wall ties, are being substituted for the air spaces. There has been no opportunity yet for comparison of the porous brick linings and air-space partition walls as to condensation. The Herculean arch tile at ceilings does not appear to be any more suitable for purpose intended than the ordinary flat-arch tile. The latter requires short spans and therefore I beams, but makes a good construction where a ceiling with some air space above it is called for, and it covers the lower flange of the beam, thus preventing condensation at a place of otherwise prolific condensation.

Steam heating or drying systems were put in at a few of the older modern batteries. Their operation in the hands of the artillery has not been successful, and the plants have fallen into disuse. The majority of them are run from boilers of the power plants, which are not large enough to spare steam for the heating. At all cases the boiler room floors are unavoidably at same level as rooms to be heated. Consequent absence of gravity return from the radiating pipes allows water to settle in the pipes when steam dies down with the not infrequent result in cold weather of freezing and bursting of pipes. Traps and valves to insure circulation and allow drainage are too delicate for the service. The heating plants being available, they were naturally used during winter to heat the rooms for comfort, rather than only at times when condensation obtains. The last steam-heating plant installed has its own boiler, of the cottage, self-feeding type, same as in an ordinary house system, although all parts are at same level. It has other changes to better suit existing circumstances, but the battery to which it belongs has been out of commission for some time, and this heating plant has only been little used. Steam heating to be worked by the troops should be the ordinary house system, having

boiler depressed below the rooms so that the return would be a gravity one, the boiler furnace self-feeding, and boiler supply delivered under pressure, as from a city main.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 5.

DEFENSES OF NEW YORK HARBOR.

[Officer in charge, Maj. W. L. Marshall, Corps of Engineers.]

GENERAL: I have the honor to submit herewith reports of Assistant Engineer G. W. Kuehnle and Superintendent John A. Yates upon the methods of construction, and results therefrom, of various forms of damp-proof wall and ceiling linings constructed by them in rooms of gun emplacements, in accord with the request of the Department and under the direction of this office.

At Fort Hamilton three cartridge rooms, and at Fort Wadsworth one shell room, were selected for lining. The rooms at Fort Hamilton were remote from the entrances to the corridors from the parade in rear, and are without means of ventilation. The room at Fort Wadsworth is near the parade wall and within 10 feet of the outside doorway, allowing the room to be rapidly influenced in temperature by outside changes. In all the rooms the proceeding was—

First. To construct a water-tight roof with proper drains therefrom.

Second. To provide a lining throughout of nonconducting material, with proper air spaces separating the linings from the cold walls.

The object of each construction was—

(*a*) To divert all leakage into channels where it should be harmless.

(*b*) To furnish nonconducting, and, if possible, noncondensing, walls, within which powder and projectiles can be stored.

The details of the structures are fully given in the text of the reports of the assistants in immediate charge at the forts, and will show on the tracings accompanying this report. The details of the linings were designed by Assistants Kuehnle and Yates and the linings carefully constructed by them.

The water-tight roofs were constructed at Fort Hamilton of (*a*) corrugated copper; (*b*) a double course of wood, covered with bitumen, with an intermediate layer of tarred paper, and at Fort Wadsworth, with wood, covered with bitumen and calked with white lead. All ceilings have proved water-tight so far.

The nonconducting linings used at Fort Hamilton were (1) lith (asbestos, with flax binder) and magnesia lumber; (2) sheathing of wood, covered with compressed cork; (3) novelty (wood) sheathing to side walls, below triple (wood and paper) ceiling.

At Fort Wadsworth the lining was of tongued and grooved wood covered with compressed cork, whitewashed.

The results, generally stated, are, from my observation—

1. All the roofs constructed have been free from leaks. Wooden ceilings have swelled and buckled to some extent.

2. Lith as a lining to magnesia lumber does not add to its value as a noncondenser.

3. Wood, although protected by asphalt or bitumen, swells by absorbing moisture, and is unreliable for waterproof ceilings on account of buckling and cracking, consequent upon such swelling. If not kept dry it will rot.

4. All substances, nonconducting or other, will show more or less condensation when they are not by free ventilation or by direct heating raised in temperature above the dew point.

5. When a perfectly water-tight roof and good drainage behind the lining is provided, a wooden sheathing to roof and sides of rooms is sufficient, provided that occasionally—once in a month or less—artificial heat (with changes of air to carry off evaporated water) is applied to raise the temperature of the linings above the dew point. If not kept dry by artificial heat or otherwise, wood or other substances liable to decay should not be used for linings.

6. In a room where a sufficient current of air or reasonable ventilation may be had, and having a tight roof, well drained, with wooden lining to walls, a dry storehouse without artificial heating may be had, the conditions to secure which are more fully shown herein below.

7. All linings at Fort Hamilton were far withdrawn from the open air and without any means of creating a current of air or freely ventilating the rooms. Under such conditions both the walls and linings remained cold, and as soon as the warm, humid air from without slowly invaded these rooms beads of condensation appeared all over the so-called noncondensing linings.

It is doubtful if these linings would have dried out during the hot weather of July and August, had not the rooms been heated artificially and a mild current created by this heating to carry off the evaporated moisture. Such linings reduce condensation, but evidently, under the existing conditions as to ventilation at Fort Hamilton, they must be dried out and heated occasionally during the summer.

STOPPING LEAKS BY FILLING, ETC.

Experiments have been continued at Forts Hancock and Totten to stop leaks by exterior applications, filling of cracks, etc., with temporary success sufficient to justify the expense. At Fort Hancock cracks and joints have been filled with roofing cement with good success. At Fort Totten filling cracks with asphalt cement and covering superior slopes with common roofing paint and sand have been successful in stopping leaks. All these processes have seemed to be temporary. The applications must be repeated at greater or less intervals of time, as may be readily deduced by reasoning upon the nature and properties of concrete.

It is difficult, if not impracticable, to permanently stop leakage through a crack in concrete, in a climate with wide ranges of temperature, by filling the crack with any substance yet used for the purpose. Cracks open in winter from contraction. If then filled, the filling will be squeezed out by expansion in summer and the cracks open again in winter, or if the filling is incompressible, it will act as a wedge in summer to further widen the crack in winter. No sufficiently elastic

substance has been found to accommodate itself to the changes due to contraction and expansion.

In this connection, i. e., widening and narrowing of joints in concrete or masonry due to temperature changes, it may be well to interject here some personal observations on the effect of frost and heat:

At Appleton, Wis., prior to 1886, when my service there terminated, was a wooden lock, upstream from which was a masonry wall about 720 feet long, capped by a coping about 1 foot or more thick, much displaced, accounted for by me as follows:

In winter cracks in the masonry coping opened and were filled by the wind, etc., with dust and incompressible material. In summer the stone expanded, and, as there was no relief by compression at joints, the bond between coping and masonry below it was broken. The ensuing winter the cracks again enlarged by contraction and the joints again filled with new incompressible material, and in summer the stones expanding moved still farther on their beds. About nine years after the wall was built a coping stone about 4 feet wide was thrust from the end of the wall, due to the gradual widening of the cracks and movement of stones by the wedging action of incompressible material blown into the cracks.

Again, in 1901–2, two 12-inch emplacements were constructed by me at Fort Wadsworth and two 12-inch emplacements at Fort Hancock. Neither of these emplacements has yet been turned over to the artillery.

A waterproof course presenting a smooth surface was placed over the rooms of these batteries, about 18 inches below the surfaces of superior slopes and gun platforms, and care was taken that no vertical joints should reach to the waterproofing.

After one winter's frosts and one ensuing summer it is apparent that the coping or concrete masonry above the waterproofing has been moved by expansion until the coping projects beyond the surfaces below, and that the movement has caused chipping and spalling along the intersection of the waterproofed surface with exposed vertical walls of the emplacements.

The filling of cracks under such conditions will only aggravate the movement of the coping by providing a fulcrum to the expansion levers. The Appleton observation had been lost on me, or forgotten, until this later movement recalled it with force.

From these experiments and observations it may appear that filling open cracks in cold weather, to be further expanded in warm weather and still further filled in cold weather, is not profitable, and it is evident from the working of the paving of superior crests at Fort Wadsworth and at Fort Hancock that the placing an approximately horizontal waterproof course of great superficial extent so near as 18 inches to a paved surface and with vertical joints between the sections of pavement above it is not good practice. The waterproofing must be as near as practicable beyond the limits of frost and the stone on both sides of it must be free from joints not parallel with the waterproof course.

GENERAL REMARKS.

In addition to a report as to the effects of certain specified and authorized linings to magazines with the object to decrease or prevent condensation, or deposit from the air, of moisture, it is deemed proper to incorporate remarks that may possibly aid in the solution of the

question, "How may we secure well-protected, dry service magazines for our powder and projectiles?"

These rooms or storehouses are far withdrawn from the open air, due the necessity for so placing them that the contents may not be reached by the projectiles of the most powerful modern guns. The rooms are caves, with the temperature of walls naturally about the same as the mean annual temperature at their location.

In summer, on our seacoast, the air is not only at high temperature, but is also highly charged with moisture, and when admitted into these rooms has its temperature rapidly reduced and gives up its moisture in great part as "condensation" on the walls and on any bodies, like powder cases or projectiles, stored therein. This reduction in temperature of the air admitted from the outside and deposit of moisture therefrom of course is represented by a heating or rise in temperature of the walls of the rooms. If air in sufficient volume, or in excess of the quantity that may be cooled to below the dew point while in contact with the walls is admitted and passed through the room before it be cooled to the dew point, no deposit of moisture will take place, while at the same time the walls of the room will be heated to an extent measured by the loss in heat units of the air passing through the room. When this current of air is sufficiently prolonged, the walls of the room will be heated up to the mean temperature of the outer air, or if the circulation be controlled in such manner that air is admitted only during the rise in temperature after sunrise, the walls may be heated much above the mean temperature, and if this ventilation be properly managed no trouble from condensed moisture may be feared.

On the other hand the quantity of moisture at any time contained in a room full of air is limited. Only so much moisture may possibly be derived from it. If the room be sealed to prevent any more air entering, then it will remain dry or approximately in the same condition as when sealed; no more moisture, no more heat can enter or be abstracted from it by convection. Dry storerooms then may be secured in two ways without artificially heating them:

First. By free ventilation at the proper time.

Second. By keeping them practically sealed when condensation on cold walls is probable.

Should the room (with its concrete walls at about the mean annual temperature) be imperfectly ventilated during the moist warm months, i. e., should air be admitted at rates and in volume so small that it may be reduced below the dew point while in contact with the cold walls, the room will be kept reeking with condensed moisture so long as the conditions exist.

In nearly all the emplacements in this district constructed prior to 1900 and provided with ventilating pipes, the ventilators are small (6 inches or less in diameter), leading vertically from the rooms. They are intended to be always open, and are therefore suited for the slow, continuous, pernicious movement just described, depending solely upon differences in density of air within and without the room. As cold air slowly passes out, warm air replaces it, generally through the same orifice, but in different directions of flow, simultaneously.

Pure air, indeed, is provided for by such ventilators, but they act rather for irrigating than for drying the rooms, and we have been compelled to stop them up in many cases.

This method of ventilation, due to differences in density in a column of air produced by differences in temperature, has been for years applied for irrigation in certain parts of the West, where the returns from the lands irrigated by the system justify the expense of applying it.

This system of irrigation, as far as I have been able to trace it, was discovered by accident when drainage of low lands near Chicago for truck gardens was attempted some ten years ago.

In this system parallel and intersecting lines of porous agricultural tile pipe are laid, buried not too deep to be reached by the roots of vegetables, nor beyond the reach of cold penetration from above, but their ends at very slightly different levels.

Both ends of pipes, or tiles, are left open during the winter, and the earth above and around the pipes is frozen. In spring the pipes are all closed, except so far as necessary for drainage. Drain pipes are closed at higher and opened at lower ends.

Whenever dry weather sets in the pipes or tiles are opened. Warm air by gravity enters, and cold air flows out in equal volume at the lower end (the length of pipe being empirically fixed), and when reduced in temperature below the dew-point deposits of water are made, absorbed by the porous tile, and eagerly appropriated by the roots of growing plants above.

In some of our works we see all this paraphernalia in somewhat different form, all intended for drying caves, but in accord with effectual irrigation schemes. There is in evidence in each case the slow ventilation by currents to and fro through one orifice, caused by changes in weight of air due to changes in temperature, with walls reeking with moisture condensed thereon. We have also the counterpart of the porous tile in the porous lining of walls, meant to absorb the condensed moisture, but we have provided no means to take up and remove this moisture. But if during the period of no condensation the previously condensed moisture be evaporated from these porous linings, and if during the moist weather condensation against these linings be readily absorbed and hidden, then such linings will be apparently dry, although when condensation is going on they are just as wet as if no absorbent had been supplied. The water is still there until evaporated, failing which removal by evaporation we will ultimately have supersaturated nonsqueezable sponges filled with water and worthless as further absorbents of moisture.

Water or moisture should not be merely concealed by temporary absorption, but should be permanently removed and all evidences of it prevented. Such removal does not merely mislead, and is believed to be possible in nearly every case.

The rules in vogue for avoiding the defects of this method of ventilating magazines simply increase the trouble and have generally failed.

Some insist that magazines should be opened only when the outside air is at a lower temperature than the magazines. The application of this rule increases the capacity of the walls to condense moisture by continually lowering their temperature; others demand mathematical determinations of the dew-point temperature and provide that magazines shall not be ventilated when the temperature of the walls is below this dew-point. The dew-point is constantly changing and the rule nearly impossible of application.

It appears that all these methods and rules should be cast aside, at

least so far as to allow methods of ventilation to be provided on the broad principle that air when not saturated will absorb and remove moisture at any temperature, and if passed over objects, masses, or walls in sufficient volume will soon reduce these walls to the same temperature as the air.

Such free ventilation has been attempted in this district, so far with sufficient success to show the principles to be correct and easy to apply, at four emplacements for 12-inch guns at Fort Wadsworth and two emplacements for 12-inch guns at Fort Hancock; but the ventilators might have been increased in size and number advantageously. The results are vastly superior to any attempts on the other system.

It may be observed anywhere that when a wind encounters an obstacle like a plane surface it piles up against it on the windward side, and a partial vacuum is produced on the lee side. If there be a hole in the surface the wind pushes air through it.

If the obstacle be a house, the pressure on the windward side will push air through every crack and aperture, into the house, if there be any path of egress in the direction of the wind, and this pressure, aided by the suction on the lee side of the house, will cause the air to flow from the house through every aperture and crack on the lee side, and there will be a continuous motion from windward to lee side of the house.

If windows on windward and lee sides of the building be opened, a much stronger current will pass through the building, whatever be the relative positions of the windows. Curtains will blow inward on the windward side and outward on the lee side.

On very cold nights, with temperatures approaching zero, without opening doors or windows on windward side of my house, upon opening quite wide a window on the lee side I have observed a stiff current outward, and that the room was cooled by air transmitted through the house from the windward side, entering through various small apertures rather than by inflow of heavier air from the lee side.

These are simple experiments that anyone interested in this system of ventilation of magazines may readily verify. It would be instructive, on the other hand, to note the effect of ventilating a tightly closed room by a vertical pipe through the center of the ceiling; or, on a small scale, the ventilation of a barrel through its bunghole in comparison with its ventilation through similar holes lying in the direction of the wind, one in each head; or the ventilation of the hold of a ship through a single pipe or two pipes abreast, all other openings being closed, compared with fore-and-aft ventilation through two or more ventilators separated the length or width of the ship measured in the direction of the wind current.

The ventilator flumes used at these emplacements are constructed as shown on the attached sketch. They are 18 inches in diameter, each arranged with a tight hinged covering in order that ventilation may be controlled from outside the batteries, and so arranged that rain can not follow the flues into the rooms. There is only one flue to each room, which has proved sufficient, but an increase in area or number is desirable and practicable.

The movement of the air through the rooms of the batteries is from the doors and windows at the parade wall in rear to and through the flues in front of the rooms, or the reverse, and when the wind is blowing across the battery at about 10 miles an hour and the doors and

ventilators opened the air in the rooms is replaced once in about one and one-half hours and kept in motion by the "draft."

In this system the rules to be followed are:

A. The rooms to be kept closed—

1. Generally throughout the winter, unless on days when there is a brisk breeze and clear weather, and the temperature well above the mean annual temperature.

2. When it is still or calm weather.

3. When the air is filled with fog or mist.

4. Generally at night and after 2 p. m.

B. The ventilation to be free—

1. Whenever there is a wind exceeding 5 miles an hour blowing across the battery and the temperature is above mean annual temperature, with no fog, mist, or rain accompanying.

2. When there is an appreciable movement in the air. The temperature not too low, and the days clear, the ventilators may be opened between daylight and noon.

3. After the temperature of the walls is sufficiently raised the ventilators may remain open during all of every day in summer when air is not unusually moist.

Free ventilation is especially prescribed whenever a wind of proper temperature is from the land and of good force, day or night, in clear weather. No instruments or calculations required, but the ventilators must be of sufficient capacity to maintain a "draft" or motion in the air through the rooms during a brisk wind.

It must be kept in mind that "ventilation" under this system means an application of the force of the wind to convey heat to the walls and to remove moisture from the rooms by absorption and convection by the air or wind currents—not simply "aeration" or the supply of oxygen for breathing purposes.

The ventilator flues shown on sketch are as actually constructed; they are not, perhaps, in the best location or of best shape.

In providing for this system the ventilators should be of large capacity and so placed that the rooms to be dried or ventilated, and the ventilator flues, should be as near as practicable along the direction or pathway of the resultant winds during the months from March to September, inclusive, with as few changes in direction as safety to contents of rooms against fire or projectiles will allow.

Respectfully submitted.

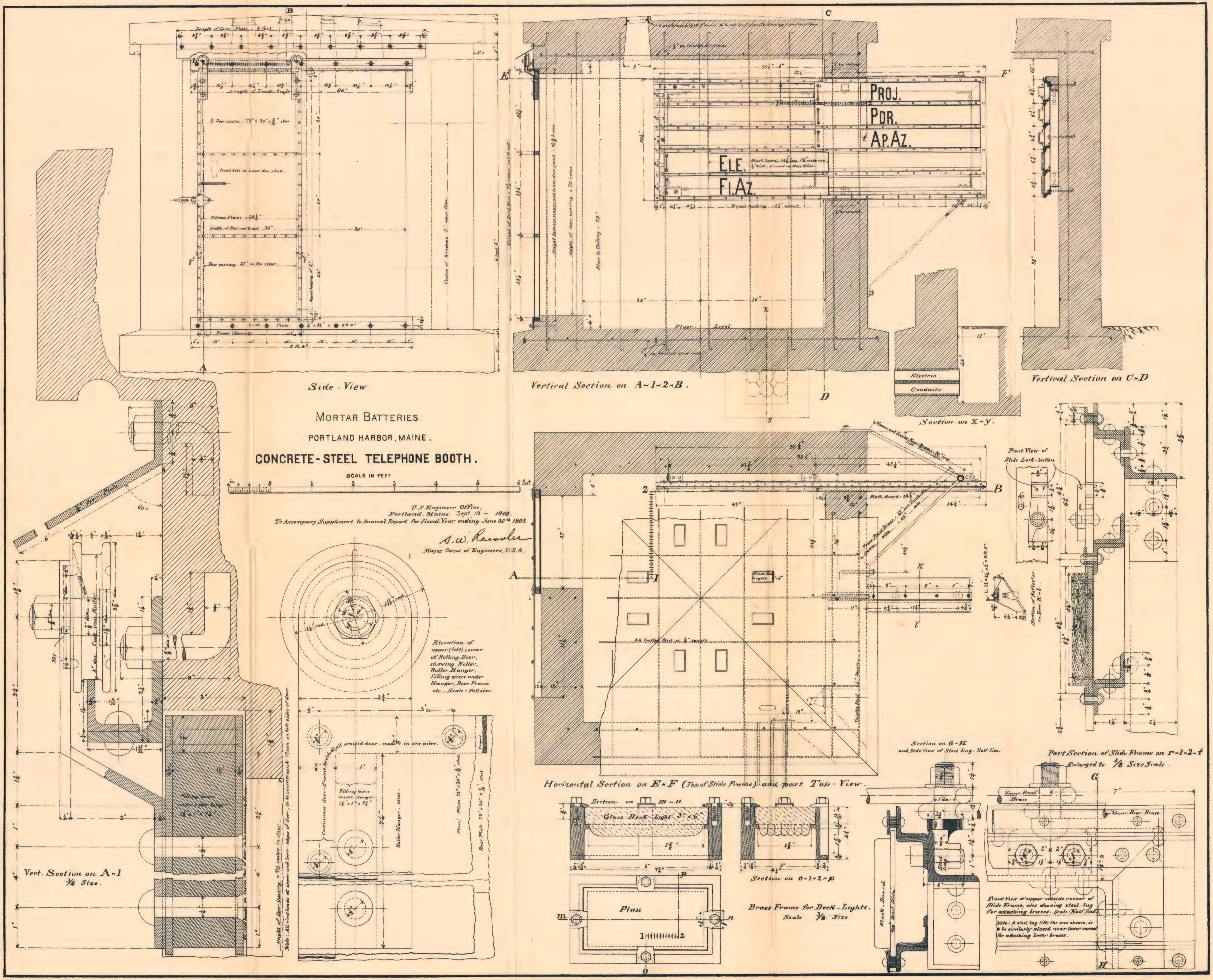
W. L. MARSHALL,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

REPORT OF MR. G. W. KUEHNLE, ASSISTANT ENGINEER.

MAJOR: In compliance with the provisions of paragraph 1, General Orders, No. 5, current series, I have the honor to submit herewith a report (duplicate) on the experimental damp-proof lining of magazines at Fort Hamilton, N. Y.

The rooms selected for the experiments were the cartridge rooms of three 10-inch emplacements. These emplacements are built of Rosendale cement concrete, and were completed in 1894 and 1895, being the oldest at this post and the ones most subject to dampness, both from percolation and condensation.



ANDREW B. GRAHAM, PHOTO-LITHO WASHINGTON D.C.

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The methods adopted had in view two purposes, one to carry off the water of percolation by collecting it at the foot of the walls and running it through the main drains of the battery, and the other to prevent or reduce condensation by lining the ceiling and walls with an insulating material.

CARTRIDGE ROOM, EMPLACEMENT NO. 7.

This room is 11 by 20 feet, with ceiling 8 feet high. The ceiling beams are 8-inch I beams, spaced 2 feet apart, with concrete arches between them.

The method adopted for this room consisted in a corrugated copper ceiling, with Lith (a composition of rock wool with a flax-fiber binder) and magnesia lumber as an insulating lining.

Down spouts were cut in each corner of the room from the ceiling to the floor, connecting with drains cut in the floor at the foot of the walls around the four sides of the room, which were in turn connected with the positive drain in the center of the room.

The copper ceiling is made of 16-ounce corrugated copper, corrugations 1-inch deep and 3 inches center to center. It was furnished in sheets 3 feet wide and 20 feet long, and is fastened to the ceiling beams with ⅜-inch special tap bolts. At each end of the sheets a copper trough is fastened, catching the ends of the corrugations. This trough extends into a groove cut in the end walls, and has a half-round depression in it sloping from the middle toward the sides of the room, so as to carry the drip to the down spouts in the corners.

The insulating material, one-half-inch Lith and one-eighth-inch magnesia lumber, is fastened under the ceiling by brass strips held in place by three-eighths-inch tap bolts screwed into the special tap bolts.

On the side walls furring strips of magnesia, one-half inch thick, are fastened vertically with expansion bolts, and the Lith and magnesia lumber lining is held in place by vertical brass strips, spaced 2 feet apart, fastened to the side walls with expansion bolts.

The cost of lining this room, including the drainage, copper ceiling, and insulating material, was $465.42 (64 cents per square foot). The work was completed in February and has been under observation since that date.

There has been no indication of leakage of percolated water, showing that the copper ceiling and drains work perfectly. The lining appears damp, but shows no moisture on its surface. The brass strips show beads of condensed moisture, and would probably be improved by being painted and coated with cork dust. The cases of ammunition stored in this room are dry.

The temperature of this room in February was 48°, in June 50°, and on August 15 it was 60°.

CARTRIDGE ROOM, EMPLACEMENT NO. 6.

This room is 11 by 20 feet, with ceiling 8 feet high. The ceiling beams are 8-inch I beams, spaced 2 feet apart, with concrete arches between them.

The method adopted for this room consisted in a corrugated copper ceiling, with wood and compressed cork as an insulating material.

Down spouts were cut in each corner of the room from the ceiling to the floor, connecting with drains cut in the floor at the foot of the walls around the four sides of the room, which were in turn connected with the positive drain in the center of the room.

The copper ceiling is made of 16-ounce corrugated copper, corrugations 1 inch deep and 3 inches center to center. It was furnished in sheets 4 feet 3 inches wide and 10 feet 9 inches long. A copper trough runs the full length of the room on each side, catching the ends of the corrugations. This trough extends into a groove cut in the side walls and has a half-round depression in it sloping from the middle toward each end, so as to carry the drip to the down spouts in the corners of the room.

The copper is fastened to the ceiling beams with three-eighths-inch special tap bolts, spaced 20 inches apart on each beam. These tap bolts have heads three-fourths-inch square and three-fourths-inch long, with a three-eighths-inch hole tapped in the center one-half-inch deep. In order to provide a slope in the corrugations from the middle of the ceiling to the sides, wooden strips increasing in thickness are fastened above the copper over each line of bolts, so that while in the middle of the ceiling the corrugations are in contact with the beams, at 20 inches from the middle on each side they drop one-fourth-inch, at 40 inches from the middle on each side they drop one-half-inch, and at 60 inches from the middle on each side they drop three-fourths-inch. Washers made of 1-inch half-round iron are placed under each tap bolt to make close contact with the bearing surfaces.

Wood-furring strips 1½ by 2 inches are fastened under the copper ceiling to the

special tap bolts, using three-eighths-inch tap bolts countersunk until flush. To these furring strips five-eighths-inch yellow-pine ceiling, tongued and grooved, is nailed, and then 1-inch compressed cork, in sheets 1 by 3 feet is nailed to this ceiling with 1½-inch yellow-metal nails.

On the side walls horizontal furring strips, 1½ by 2 inches, with a one-half-inch bevel toward the wall, are fastened 16 inches apart with one-half-inch bolts spaced 3 feet 6 inches apart. To these strips five-eighths-inch yellow-pine ceiling is nailed and to the ceiling the 1-inch compressed cork is fastened as above.

The cost of lining this room, including the drainage, copper ceiling, and insulating material, was $427.90 (59 cents per square foot). The work was completed in February and has been under observation since that date.

There has been no indication of leakage of percolated water. Up to July 1 this room was perfectly dry; after that date beads of condensed water began to show on the ceiling, and by August 1 the ceiling and side walls were covered with moisture. The cases of ammunition stored in this room were wet.

On August 3 the ammunition was taken out and the room heated with an oil stove, which was kept burning as near continuously as possible for four days, or until August 7, the temperature running up to 94° on that day. At the end of the four days the lining was perfectly dry and has remained so since.

The temperature of this room in February was 48°, in June 52°, and on August 15 it was 62°.

CARTRIDGE ROOM, EMPLACEMENT NO. 5.

This room is 13 feet 6 inches by 20 feet 6 inches, with ceiling 8 feet high. The ceiling beams are 8-inch I beams, spaced 2 feet apart, with concrete arches between them.

The method adopted for this room consisted in lining it with wood, leaving a dead air space between the lining and walls.

Drains were cut in the floor at the foot of the walls around the room and connected with the positive drain in the center of the room.

The ceiling consists of two courses of yellow pine, the top course being 1 inch and the bottom course five-eighths-inch thick, laid at right angles and having a layer of tar paper between courses. The ceiling was nailed to furring strips fastened to the I beams with three-eighths-inch tap bolts and has a slope of 2½ inches from the middle of the room toward each side.

The side walls were lined with 1-inch novelty siding, nailed to 3 by 4 inch posts, fastened vertically to the walls with one-half-inch bolts. All the wood was coated with bitumen dissolved in gasoline.

The cost of this lining, including the drainage and lumber, was $188.33 (24 cents per square foot). The work was completed in April.

There has been no indication of leakage from percolated water.

Shortly after completion this lining was covered with moisture. On July 7 an oil stove was placed in the room and kept burning continuously until July 18, at which time the room was perfectly dry. The temperature varied from 72° to 85°, depending on the opening of the door for ventilation. Since July 18 the room has been dry.

The temperature of this room in April was 50°, in June 53°, and August 15 it was 66°.

Tracings showing details of the methods used are forwarded herewith.

Very respectfully, your obedient servant,

G. W. KUEHNLE,
Assistant Engineer.

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. Army.

REPORT OF MR. JOHN A. YATES, SUPERINTENDENT.

MAJOR: I have the honor to report on the method of the interior waterproofing of a shell room at Fort Wadsworth, N. Y. This room was selected as being the most difficult problem in the way of interior waterproofing at Fort Wadsworth, the room being the dampest, leaks more in evidence, and the waterproofing about the ammunition trolleys and fastenings being very difficult.

The battery in which this shell room is located was constructed in 1897. No provisions were made at that time for air chambers, underdrainage, or waterproof covering; consequently all rooms and passages were leaking continuously, the walls and ceilings being continually wet, and puddles of water on the floor to the depth of 1 inch or more.

An effort was made in 1899 to asphalt the ceiling and walls and then place a cork lining on the asphalt covering. The contractor abandoned his contract after delivering material, probably considering the problem was too difficult.

Subsequently I experimented with giving the walls a coating of asphalt, resin, and Spanish brown. The walls were first dried thoroughly and the coating applied. It was found the magnesia or alkali was so strong that it easily cut the resin in the composition, thus making this effort futile.

Pursuant to your instructions contained in your letter of September 9, 1902, a thorough system of underdrainage was made for all rooms and passages. I then decided to make an interior lining of wood, consisting of a sheathing of seven-eighths by $3\frac{1}{2}$ inches tongued-and-grooved white pine. The method of fastening and details are as follows:

Ceiling beams (flush with ceiling) were first drilled and tapped with three-eighths-inch machine bolts placed 16 inches center to center for fastening furring strips to the ceiling.

Furring strips of 1 by 2 inch spruce were first coated thoroughly with one coat of Venezuela asphalt (98 per cent bitumen). These furring strips were then fastened to the ceiling with the three-eighths-inch bolts, the bolts being countersunk in the furring strips so as to present an even surface. The furring strips were then placed 16 inches center to center, with a fall from the center of room both ways of $1\frac{1}{4}$ inches. Furring strips were then blocked solid at each bolt and where the trolley brackets rest.

Ceiling.—The ceiling, consisting of seven-eighths by $3\frac{1}{2}$-inch tongued and grooved white pine, was then coated on all sides and edges with the asphalt, which was applied with fine wire brushes and was then "blind" nailed with 8-penny wire nails into every furring strip, each ceiling piece being placed on separately, at the same time using a blow torch on the tongue and groove of every ceiling plank sufficient to warm the coating so as to permit the next board to be thoroughly sealed and waterproofed to the adjoining one. As the sheathing was placed, holes of 1-inch bore were made through sheathing for receiving bolts for trolley brackets.

Side walls.—Three rows of holes were drilled in the concrete on all sides, top row being 8 inches from ceiling and bottom 8 inches from floor, the third being in the center of the walls. These holes were drilled with a $1\frac{1}{4}$-inch drill about 5 inches deep, spaced 16 inches center to center. Plugs made of $1\frac{1}{4}$-inch spruce were then driven in the holes tightly and then cut off flush with the face of the wall. Furring strips thoroughly coated with asphalt were spiked into plugs with 20-penny wire nails.

Sheathing side walls.—On furring strips above mentioned a sheathing for the side walls of seven-eighths by $3\frac{1}{2}$-inch yellow pine, tongued and grooved, were first thoroughly coated on all sides with asphalt, and then "blind" nailed and placed horizontally into every furring strip with 8-penny wire nails. This method practically forms a wooden interior lining, with an air chamber equal to the thickness of the furring strip. The drainage of this air chamber was made easy owing to the removing, relaying, and redraining concrete floor.

After completing the ceiling an additional coat of asphalt was applied over all surfaces to cover all possible seams and cracks. The trolleys and brackets were then replaced and all bolts in brackets were bedded thoroughly in a thorough coating of "Atlantic" white lead.

Cork covering.—The entire surface of the ceiling and side walls were then covered with a cork lining one-half-inch thick, 12 inches wide, and 3 feet long, all joints being broken and put together and fitted to the ceiling and walls and around the trolley brackets as well as the electric lamp fixtures. This cork lining was applied to the ceiling and walls by first dipping one side in the hot mixture and stuck directly on and nailed with wire lath nails, making a complete finish.

Results.—The room is practically dry, there being no evidence of moisture or dampness on the floor or no condensation, the latter probably owing to the proximity of the room to the outer air.

Several damp places about the walls are in evidence, average about 1 foot in diameter, not connected or reaching to the floor—probably owing to the method in driving the nails in the sheathing as well as the treenails or wooden plugs driven in the concrete to hold sheathing, which should have been driven downward so as to prevent the flow or outlet of water along the wall.

The area covered was 440 square feet, at a cost of $178.91, labor and materials, or approximately 40 cents per square foot. I believe this method of lining, especially about a damp or leaking magazine, is eminently practical. The cost per square foot should be materially reduced in view of the saving of labor about trolley systems.

Respectfully submitted.

Jno. A. Yates, *Superintendent.*

Maj. W. L. Marshall,
Corps of Engineers, U. S. Army.

B B B 6.

DEFENSES OF BALTIMORE, MARYLAND.

[Officers in charge, Col. Peter C. Hains, Lieut. Col. Chas. J. Allen, and Col. W. A. Jones, Corps of Engineers.]

GENERAL: In compliance with the instructions contained in paragraphs 1 and 5 of General Orders, No. 5, current series, from your headquarters, and in your letter dated March 11, 1903, I have the honor to report as follows:

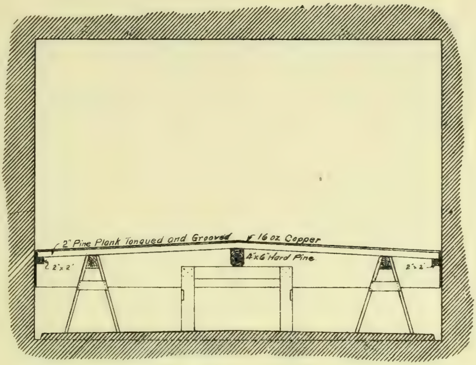
In the matter of damp proofing the rooms and galleries of the fortifications for the defense of Baltimore, Md., conditions have changed, owing to results developed by severe weather since the report of Lieut. Col. Charles J. Allen, Corps of Engineers, dated April 15, 1903. The season, since that date until the early part of July, was one of heavy and prolonged precipitation, saturating the earth fill and wetting the masses of concrete in the batteries. The heated term began in the latter part of June, accompanied by excessive humidity. The variations in temperature were unusual for the season. The early part of August was of lower temperature than the normal. The effect from these sources upon the rooms in the emplacements was more pronounced than at any time since their construction.

Percolation through the masonry and condensation of moisture in the magazines were generally greater than had before been apparent. The rooms and galleries which had been treated with metal ceilings collected and carried off the water due to percolation from the roof, but all showed more or less signs of condensation. The side walls have not been treated, except tentatively in a few sections, and were in degree damp to wet from leaks and condensation. Most of the rooms and galleries which have not been treated for dampness were generally from moist to wet from both leaks and condensation.

Metal ceilings have been used in some of the batteries, and no other emplacements have been damp proofed, further than applying hot asphalt to the outside vertical concrete walls supporting sand and earth fill, and, also, in one instance, installing a steam-heating apparatus to reduce condensation, which partly counteracts condensation.

The details of construction in applying metal ceilings and other damp-proofing processes in this district are illustrated in the report and accompanying maps printed, commencing on page number 2460 of Appendix Z Z to the Annual Report of the Chief Engineers for 1902. In brief, the method finally adopted was to put in thin galvanized sheet-iron ceilings, dripping into side gutters discharging into down spouts leading to drains in the floors; relaying concrete floors, crowned to drain to side gutters; cork painting all exposed metal except trolley rails; uncovering vertical faces of concrete walls supporting earth fill and applying hot asphalt; taking up and relaying platform surfaces that had settled out of grade; calking outside cracks with oakum and applying linseed oil mixed with coloring matter to all exposed surfaces of concrete.

From careful observations at frequent intervals of the effect of damp proofing in this district, especially during the unusually humid conditions of the latter part of August and part of September, 1903, it may be stated that none of the previous methods have proved themselves



— End Elevation Showing Ceiling Before Being Raised to Place. —

The plank ceiling, which consists of 2" pine plank, was made up first, then the sheet copper put on and soldered and finally the completed ceiling lifted to place by means of jacks.

FORT CONSTITUTION, N. H.

SKETCH SHOWING

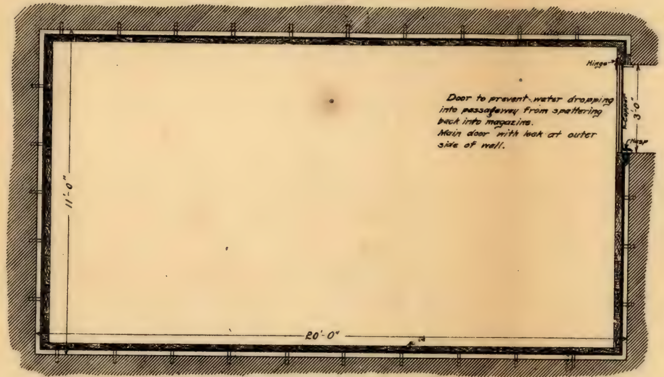
METHOD OF LINING MAGAZINES.

Scale ¼ in. = 1 ft.

U.S. Engineer Office, Boston, Mass.
August, 13, 1903.
Respectfully forwarded to the Chief of Engineers with letter of this date.

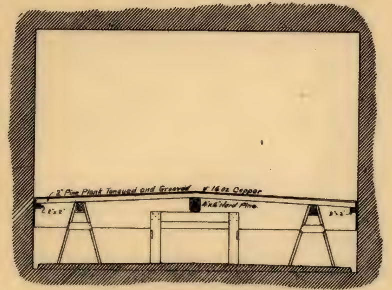
Harry Taylor
Captain, Corps of Engineers.

Drawer 16, Sheet 38



— Plan Showing Lining in Place. —

— End Elevation Showing Lining in Place. —



— End Elevation Showing Ceiling Before Being Raised to Place. —

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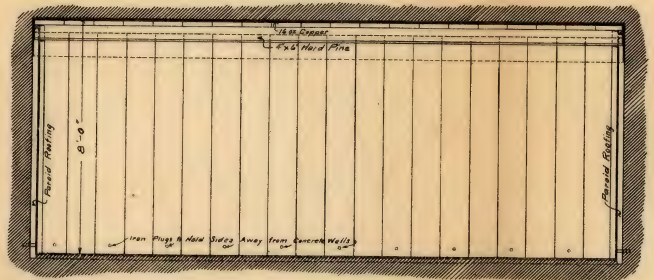
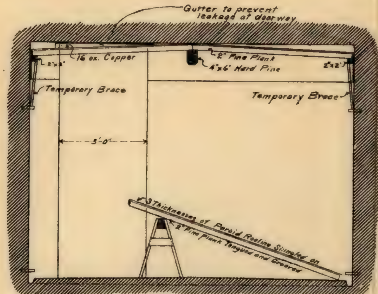


— Side Elevation Showing Lining in Place. —



End Elevation Showing Ceiling After Being Raised to Place and Method of Building Sides.

The ceiling after being lifted to place is held by short braces from pins in the walls while the sides are being built and placed.

FORT CONSTITUTION, N. H.

SKETCH SHOWING

METHOD OF LINING MAGAZINES.

Scale ¼ in. = 1 ft.

U. S. Engineer Office, Boston, Mass.
August, 13, 1903.
Respectfully forwarded to the Chief of Engineers with letter of this date.

Harry Taylor
Captain, Corps of Engineers.

ANDREW B GRAHAM PHOTO LITHO WASHINGTON, D.C.

as a useful and satisfactory solution of the problem, and another method has been tried which seems to solve the problem, but until it has been subjected to the adverse conditions over a longer period of time perfect success can not be safely announced. But one thing may be said, and that is, that a long step in advance has been taken, and there is no doubt that a perfect solution of the problem lies in the application of the principles which guided in the development of this method. I will now present an analysis of the principles involved in the problem.

THE PRINCIPLES INVOLVED.

Certain solids are soluble in certain fluids. This means that when the solid comes in contact with the fluid, that contact develops forces which mechanically break up the solid into particles invisibly small, which adjust themselves among the voids between the elementary particles of the fluid, and will continue to do so until those voids can contain no more of the particles.

In a similar way certain fluids coming in contact with certain gases are broken up into invisibly small particles, which adjust themselves within the voids of the gas up to a limit called saturation. Water in contact with unsaturated air always breaks up into invisible particles, called aqueous vapor, along the surface of contact and passes without other change into the voids of the air. Water even does this from snow and ice, its solid condition, and a great many solids and fluids do the same. In the case of snow, the surface of contact being enormously increased, as a result of the multicrystalline conditions, the solution goes on at a greatly accelerated pace, and hence it is probably true that far more snow is carried off by gaseous solution than by melting into water.

It is this invisible water in the air which is a prime factor in the problem of damp chambers.

Heat is also an important factor in the matter. The higher the temperature of the air the greater the quantity of water that it will take up and carry. Under the influence of heat the repellant forces among the particles of the gas evidently become intensified, driving the particles farther apart and increasing the volume of the voids between them. I am using the term gas in a general way. The atmosphere being a compound gas in which oxygen is probably dissolved in nitrogen. One of them certainly occupies the voids between the particles of the other.

Water can be forced into one of its vapor conditions by heat. This is called steam, but in this case the water has not been invisibly divided. We can see it. From this condition, when in contact with the air, it again becomes broken up by the air into the infinitely divided and invisible form called aqueous vapor, with far greater facility than from the liquid form.

And so evaporation is but another term for solution—evaporate for dissolve.

When a fluid is charged to saturation with the particles of a solid, if we take away any of it without changing the quantity of the solid particles, the surplus of these particles, having no voids to occupy, drop out, as we say, but not properly, and assemble upon each other under the forces of crystallization until they become heavy enough to

fall to the bottom as crystals, of size varying with the rate of change and the nature of the solid.

The higher the temperature of air the greater the quantity of water vapor it will carry. If a body of air is saturated with such vapor a decrease in its temperature makes it imperative that the surplus vapor shall "drop out," and as the invisible particles become free they assemble together in the spherical shape under the influence of forces similar to crystallization, until they become visible, and on the surface of a cool wall they will keep on assembling and increasing in size until the spherical drops have to fall from the wall on account of size and weight. If a body of air is not saturated, by reducing its temperature sufficiently it will reach and go beyond the point of saturation and the surplus vapor will "drop out."

The temperature at which air, carrying a certain quantity of vapor per unit of volume, will become saturated and let the vapor "drop out" is called the "dew point," and this brings us to the vital point of our problem. Where the temperature of our walls is so low that the heat in the contact air will pass into them by induction and be carried off into the wall mass until the air on the surface of contact becomes reduced in temperature to and below the dew point, the aqueous vapor will precipitate upon the surface of the wall.

And this leads at once to the solution of our problem. If we could prevent the loss of heat by induction along the cool wall surfaces there would be no precipitation until the whole body of air in the chamber should become oversaturated—a condition which in practice will not occur.

We have to deal with chambers whose walls, floors, and ceilings are surfaces within great masses of masonry or concrete. The temperature of the walls, which these surfaces are in contact with and a part of, is nearly constant. In winter it is above that of the air which surrounds the structure, and in summer it is below. The moisture in this air is the prime factor in the problem of keeping the walls of the chambers in a dry and serviceable condition.

The quantity of water vapor in the air at a given spot at a given moment of time has not yet been subjected to precise measurement by practical means. Perhaps the best instrument is the wet and dry bulb hygrometer. With this instrument we may deduce the quantity of water per unit of volume of air, and also the relation of that quantity to the whole quantity which that unit, under the same conditions, will contain when it is saturated. Air is saturated with aqueous vapor when the addition of a greater quantity will cause the surplus to be precipitated in the form of water. When water is precipitated from solution in air it comes out, and we first see it as a mist, in extremely divided particles. When this mist falls through any considerable distance in air at saturation or nearly so, the particles are drawn together by an attraction, probably electrical, and form drops of rain which vary in size according to the distance traversed and the force from the attraction.

This rain as it falls upon, or gets upon, the exterior surfaces of our structures of masonry or concrete, enters within them unless the said surfaces are at the time impervious to the passage of water. It enters under the influence of two forces: (1) gravitation, (2) capillarity. The one draws it downward, the other in all directions. Concrete and mortar are of necessity very porous and not homogeneous, and

hence water coming in contact with the surfaces of our concrete structures will be carried into them and through them in surprising ways and to surprising distances.

Within our chambers we have to meet and control water coming to their floors, ceilings, and walls by percolation from without and precipitation within. There is one, and only one, practical and business-like way to control the former, and that is by rendering the exterior surfaces of the masses impervious to moisture or else by placing each chamber within a secondary mass whose exterior surfaces are impervious or will deflect the water elsewhere.

It is a simple matter of dollars and cents in any particular case which is preferable.

Within the chamber the quantity of aqueous vapor per unit of volume of air is a function of the same things as in the immediately adjacent air without and will be nearly but not quite the same.

As previously stated, there is a period of the year when the temperature of the walls of the chamber is higher than that of the surrounding air. Under such conditions communication may be freely made, and since the air on the wall contacts can not be reduced in temperature, there will be no precipitation and the walls will remain dry.

In summer and early fall these conditions are reversed. The wall temperature is lower than that of the surrounding air and the heat and humidity of that air at once become vital and active factors. The higher its temperature and the greater its humidity the greater the quantity of water which can be unloaded upon the wall surfaces, and as the maximum of these adverse conditions obtain upon the Atlantic and Gulf coasts in the season above cited, the water collected within the operating chambers of our forts becomes then and there a maximum.

But it is a controlling fact that these chambers must be rendered not only dry but comfortable for men to work in, if our forts are to be in a satisfactory condition of efficiency. They must be dry. They must be light and cheerful. They must be clean and so arranged that these conditions may be easily maintained under service conditions.

And this makes the use of granulated cork unsatisfactory. It is dark and it is dirty. It can not be held on by a coat of paint because such paint is an excellent conductor of heat. I have seen painted cork reeking with moisture, and this rules out metal ceilings. Without cork they gather moisture freely, and this should be the case, because the use of substance of high capacity for conducting heat is not a logical deduction from the principles involved.

In developing a system I have been guided by one general principle: There can be no condensation if the escape of enough heat into the walls from the air in contact with their surfaces can be prevented. This leads to an examination of the heat-conductive capacity of substances that are practically within our reach. I have prepared the following table from the authorities on the subject, assuming the conductivity of copper to be 1.00:

Heat conductivity.

Copper	1.000000	Firwood (along fiber)	0.000470
Iron	.200000	Firwood (across fiber)	.000260
Stone	.005900	Paraffin	.000140
Sand	.002600	Wool	.000120
Water	.002000	Paper (unsized)	.000094
Glass	.000500	Air	.000049

It is interesting to note that air is the greatest of nonconductors, but this means dry air occluded from contact with other air. Wool has the property of locking up air so that its conductivity can not be much changed, and this gives it its value as clothing. The different mineral substances used as boiler and steam-pipe coverings depend entirely upon the air which they occlude. The "paper (unsized)" used extensively as "deadening felt" in floor coverings and partitions derives its great nonconductivity from the same principle.

And so in interposing a nonconducting mask between the walls and the air of our chambers I have selected soft pine wood, paper felt, and paraffin, because they are all cheap and in abundant supply. To overcome the objection that a felt surface is dark and forbidding in color, and that it can not be kept clean, I have laid over it a surface of cheap white cotton duck, which can be washed and kept clean, and will always give the rooms a bright and cheerful appearance.

Paraffin, or mineral wax, is a by-product in the refining of mineral oil. The crude wax has a slight yellow color, but the refined product is colorless. It softens at temperatures above 90° F., and melts at from 110° to 150°, according to degree of refining. It is insoluble in, and unaffected by, water, acids, or alkalies. It is permanent under all conditions of weather. The valuable properties of asphalt in engineering construction are largely, if not wholly, due to its presence. It is very cheap, costing from 6½ to 12 cents per pound. Seven and one-half pounds melted make 1 gallon. In the fluid state it has an extraordinary penetrating property, and it will enter within the finest pores of a substance for quite a distance. It has been used in the preservation of decaying wall surfaces, and is a specific for that purpose when properly applied.

Paraffin has to be applied in the melted condition with a brush, the hotter the better, upon surfaces that have been made as hot as possible by the use of a kerosene blow torch. Under these conditions it enters the wall surfaces with great facility and forms a layer within the surfaces and locked therein within the interstices of the wall.

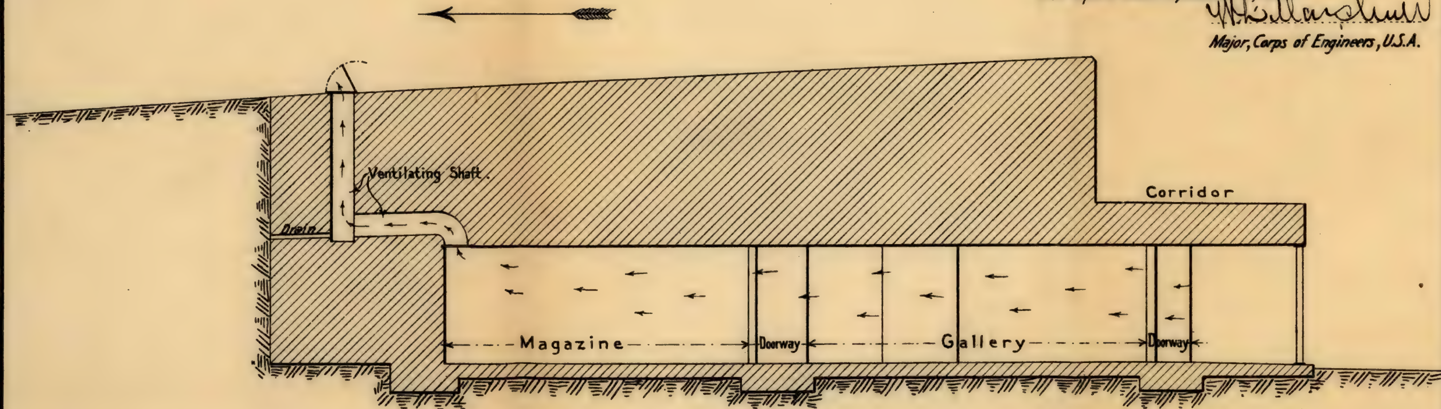
Wherever possible I propose to stop percolation by cutting off the supply of water from without. With structures in course of erection this is an easy matter, but with mortar batteries whose chambers lie within great masses of earth we have to catch the percolation as it comes, on auxiliary ceilings, and lead it away in drains along the sides of the floor. Some relief may be produced by taking off a shallow layer from the superior slopes and introducing an impervious layer of clay puddle sloped so as to carry the surface water out upon the exterior slopes.

Assuming charge of this district in June last, I have not had time to develop a system and put it in practice in time to subject it to the whole of one adverse season. I have taken the worst place in the district, the plotting room and its gallery of approach, in the east traverse of a mortar-battery. Here, when operations were commenced on August 11, 1903, the condensation was something enormous. The water stood in a great pool all over the floors, and the walls and ceilings were covered with water as thick as it could hang on. On September 3, 1903, the room and gallery were completed. Since then there have been several days when all the other rooms in the battery were wet, but these have remained dry. The method employed is fully illustrated in the sketch herewith, and is as follows:

Vertical Section through
Traverse of Gun Emplacement
showing
Method of Ventilation.
1903.

Forwarded to the Chief of Engineers, U.S.A.,
with report dated September 5, 1903.

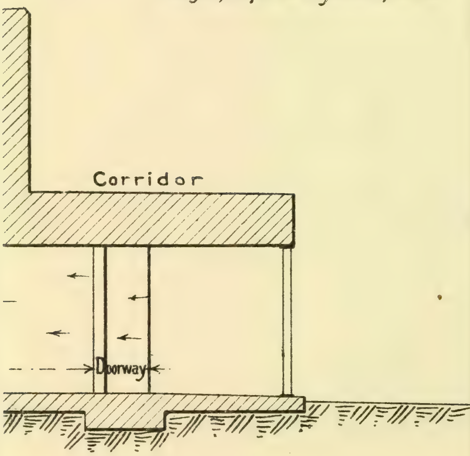
Major, Corps of Engineers, U.S.A.



ANDREW B GRAHAM, PHOTO-LITHO WASHINGTON, D.C.

warded to the Chief of Engineers, U.S.A.,
report dated September 5, 1903.

Major, Corps of Engineers, U.S.A.



Placed hot paraffin on the concrete roof, side wall, and floors; embedded the iron roof beams in concrete and placed hot paraffin on the outside surface; placed soft white-pine ceilings and side walls with hot paraffin on the upper surface of the ceiling, and fastened deadening felt and white canvas to the outside surfaces with copper tacks, leaving air spaces all around; laid new concrete floors with gutters on outside edges; paraffined the concrete floors and laid on deadening felt, followed by soft white-pine flooring, paraffined on the outside.

The cost has been 24.8 cents per square foot, but this has been the result of the novelty of the operations, and with practice can be reduced at least one-half.

* * * * * * *

Very respectfully, your obedient servant,

W. A. JONES,
Colonel, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 7.

DEFENSES OF WASHINGTON, DISTRICT OF COLUMBIA.

[Officer in charge, Lieut. Col. Charles J. Allen, Corps of Engineers.]

GENERAL: In obedience to the requirements of General Orders, No. 5, Headquarters Corps of Engineers, U. S. Army, Washington, April 21, 1903, I have the honor to submit the following report of measures taken for damp-proofing of magazines, etc., in the fortification district in my charge.

The batteries at both Fort Washington and Fort Hunt are built on and partly sunk in a clay soil which retains water, rendering satisfactory drainage difficult.

When the older works were planned there had not been experience to draw upon in designing with reference to the question of condensation of moisture in the rooms, or even of percolation through the masses of concrete; hence they afterwards required considerable attention in order that they might be made satisfactory. In the more recent battery construction, past experience has been kept in sight, and with good results.

The steps taken, in constructing and in repairing these batteries to keep them dry may be classified under the following heads, according to the object in view.

(*a*) *The prevention of seepage (or percolation) of water from outside through the concrete and of the absorption of water from the surrounding soil.*—To prevent water falling upon the superior slope from entering the concrete mass the surfaces have been made smooth and even with a granolithic finish, except for the customary joints, so that the water would readily flow off. It was found that a small amount of water from these surfaces found its way into the batteries, however, mainly through the joints and through small cracks in the concrete. Some of these joints and cracks were cut out, grouted, and pointed up

with cement mortar, some were filled with oil, others with a plastic cement, and a few were calked, but without permanent satisfactory results. A material known as "Insulatine," which is melted and poured into the joints and cracks and is claimed to possess superior adhesive and elastic properties, as well as to be absolutely water-excluding, is shortly to be tried for this purpose.

The entire concrete superior slopes of several of the batteries were also coated with a cement wash mixed with lampblack, with the double purpose of rendering them impervious to water and of experimenting upon coloring the concrete exposed to view. This was, however, unsatisfactory, as the coating soon wore or washed off. "Ironclad," a superior quality of oil paint, was tried over a limited area with much better results, though as to color it faded somewhat. Experiments are proposed to be tried with "Konkerit coating" and with "Nicolite," both of which are patented waterproofing compositions, and, like "Ironclad" paint, can be furnished in an olive-green or other desirable color. The coating of the concrete with linseed oil has been tried to some extent. Paraffin has been found to give good results in making concrete water-tight. It was given a severe test by applying it to the inner surface of the cable-tank walls. Vertical walls of concrete in juxtaposition to earth parapets have been coated on the outside with hot asphalt or with tar. The latter has not proved satisfactory, however. The vertical walls of some of the older batteries have been uncovered and treated thus; then back-filled.

The upper surfaces of concrete, which were to be surmounted by earth, have been covered with asphalt, and in a battery now under construction sheet lead is to be used over the tops and front and sand will be used for filling.

In most of the recent batteries at least a foot of gravel, broken tile, or broken brick has been placed around the outside of the concrete mass with agricultural drain tile at the foot of the same and connected with the drainage system, so as to carry all water freely away from the face of the masonry.

In a battery now under construction the concrete is faced with a tile wall 4 inches thick, suitably drained, outside of which is 1 foot of gravel and broken tile and then 4 to 9 feet of underdrained sand.

A layer of broken stone 1 foot thick and thoroughly underdrained by porous tile has been laid under floors of batteries to keep the foundation area dry, and in a battery now being built a double damp-proof layer, one of "marine cement" and one of "Konkerit coating," is to be laid on the floor, to pass out through the walls so as to connect with other damp-proofing material, and thus completely envelop the magazines.

To prevent any water which may work into the concrete mass from entering the magazines and other important rooms asphalt waterproofing has been laid on the concrete over these rooms, which have been surrounded by intercepting tile air spaces connected with the general drainage system.

(*b*) *Prevention of condensation.*—Condensation has been greatly reduced, in some cases made almost nil, by using linings of hollow, porous tile, probably aided in some cases by horizontal ventilation pipes of tile having a small drip outward. An exception, however, as to tile exists in the case of one old battery where seepage through the con-

crete mass covered by the tile undoubtedly has its effect. It is proposed to extend the use of this tile wherever practicable to do so.

The ceiling tiles are flat arch tiles; as laid of late years, they cover the lower flanges of the **I** beams by which they are supported. The tiles, being placed before the concrete is laid, are well bonded into the same and save considerable expensive forming.

Dressed pine plank and cork plank have been experimented upon, but the results obtained have not been as good as with tile.

Ventilation through large unglazed pipes, draining outward, has been employed with satisfactory results in some of the recent works. Stoppers are to be used to close the openings when necessary.

The good effect of steam heating in the prevention of condensation and for drying up of damp rooms has been experimentally ascertained, and it is believed that this auxiliary for keeping magazines dry is worthy of further and more extensive test.

(*c*) *The exclusion of rain water.*—During driving rains much water formerly entered some of the batteries, the older ones especially, particularly around the ammunition lifts, at the open areas in the old type of platform, and around the doors. This has been largely overcome by providing hoods over the lifts and doors, constructing storm doors over the areas, and providing good sills and rapid floor drainage at these points. It is proposed to extend this improvement as funds become available.

Light galvanized-iron hoods supported on wrought-iron frames have been found to be superior to cast-iron lintels bedded in the concrete during its construction.

(*d*) *The rapid carrying off of water which may find access to the batteries.*—An ample drainage system has been provided at all of the batteries, but in the older structures the floors were not all provided with sufficient slope; they frequently contained minor irregularities, in some cases due to wear, in which water collected. A number of floors which were deficient in drainage slope or were irregular in surface have been taken up and replaced by hard, smooth, granolithic paving, without joints, and affording ready discharge for all water which may reach them.

In a few rooms where there was considerable leakage metallic ceilings have been inserted to intercept the water and convey it to the drainage system. These ceilings consist of No. 24 corrugated galvanized iron supported on steel I beams and angles and draining into gutters and downspouts, which are accessible for clearing of sediment deposited by the water. To prevent condensation the metal was treated with two coats of light-colored paint ("Galvanum" paint being used on the galvanized iron), and then, while moist, coarse and then fine sifted cork was thrown against them until they were thickly covered with the cork.

The accompanying sketch is typical of the metal ceiling above described. It also shows the tile linings, air spaces, etc., above referred to.

Recurring to the mention of lampblack, it may be well to say here (though not bearing upon damp-proofing) that this material, in strong proportion, was mixed with granolithic superior-slope covering several years ago, in order to give a dark color to the covering. It served quite well for a time, but the coloring eventually faded. To

assure a stable tint more substantial and heavier coloring matter has to be used.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Lieutenant-Colonel, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 8.

DEFENSES OF THE COAST OF NORTH CAROLINA.

[Officers in charge, Capt. E. W. Van C. Lucas and Capt. E. Eveleth Winslow, Corps of Engineers.]

GENERAL:

* * * * * * *

The only means that has been employed at Fort Caswell, N. C., for prevention of dampness in the rooms of the different emplacements was the treatment of outside surfaces with boiled linseed oil, applied as paint with a brush, and the installation of positive drainage throughout the different batteries. After several coats of oil were applied all leaks stopped with the exception of one in Caswell in the vicinity of the ammunition lifts and one in the shot gallery of Battery Swift.

For the past season the oil treatment has been suspended with a view to determine to what extent the same would be efficacious in permanently stopping the leaks and excluding moisture from the mass of concrete. The result has been that the leaks are again appearing, and while they are not as bad as formerly, it is evident that the treatment will have to be resumed and continued periodically for a period as yet undetermined.

It is thought that eventually, if the treatment be continued, say once every six months, that it may culminate in stopping all leaks except through large cracks which continue to open by settlement, and, in fact, most or all of the leaks that have reappeared since the suspension of the treatment are due to this latter cause.

These cracks will have to be watched, and when the mass of concrete reaches a state of rest, if it ever should, they should be cut out and repaired.

Very respectfully,
E. EVELETH WINSLOW,
Captain, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

(Through the division engineer.)

[First indorsement.]

OFFICE OF DIVISION ENGINEER, SOUTHEAST DIVISION,
Savannah, Ga., September 21, 1903.

Respectfully submitted to the Chief of Engineers.

The painting of the upper surfaces of concrete at Fort Screven has shown some such results, and I believe that a paint made of coal tar and

kerosene oil, such as has been successfully used at Fort Monroe, will prove more effective than the oil paint, which seems to be acted upon unfavorably by the lime in the cement.

JAMES B. QUINN,
Lieut. Col., Corps of Engineers,
Division Engineer, Southeast Division.

B B B 9.

DEFENSES OF THE COAST OF SOUTH CAROLINA.

[Officers in charge, Capt. J. C. Sanford and Capt. G. P. Howell, Corps of Engineers.]

GENERAL:

* * * * * * *

The battery of 10-inch rifles was built in 1898 with Rosendale cement. The magazine and shell room for each emplacement are located on the left flank of the gun. A 15-inch air space separated by a 2-foot wall of concrete surrounds the two rooms on three sides. The fourth side communicates through doors 4 feet wide with the main passageway. A 4-foot wall of concrete separates the rooms. There is no connection between the air space and the rooms, and no ventilation for the rooms except through the door leading to each. The air space extends around the circular rooms underneath the loading platform and communicates freely with the external air at each end.

The floor of the magazines is 10 feet above mean low water. The scarp wall is founded at reference of about 8 feet. It extends around the front and both flanks of the battery with return walls to the concrete parapet, thus fully encircling the battery. In the vicinity ground water stands at about reference 8 feet. The mass of sand impounded behind the scarp wall has no drainage beyond the natural soaking of the water through the sand to the ground water.

Waterproofing methods were not employed in building the battery. The top surfaces were made with Portland cement. Nos. 2, 3, and 4 have always been leaky, especially Nos. 2 and 3. Through the large and numerous cracks in the top surface water easily finds its way through the spongy concrete to the interior rooms. Condensation in the moist, warm climate is aided by the construction of the ceiling—I beams at 2-foot intervals, with corrugated iron between, resting on the flanges. An allotment of $900 was made for ceiling all four of the magazines, $168 for lining the side walls of magazine No. 3 with magnesia lumber, and $590.11 for lining magazine No. 2 with cork board.

Emplacement No. 3.—The plan adopted for the ceiling was that described on page 2462, Report of Chief of Engineers, 1902, and illustrated on sheet No. 4, accompanying Colonel Hains's report. Gutters were cut into side walls, however, instead of being supported on brackets. The corrugated iron was No. 27, five-eighths inch between top and bottom of corrugations, and came in sheets 24½ inches wide and 84 inches long, approximately one-half the width of the magazine. It was expected that the sheets would become pitted, and it was decided to erect the ceiling so that it could be easily taken down for repairs. Angles

1 by 1 inch extended from the center of the room to the side walls. On these the sheets were placed overlapping by two corrugations fastened together and to the inch angles by nine-sixteenths-inch brass screws spaced 2 feet apart. The screws were put in at the top of the corrugations. The angles did not keep the sheets in line, and they became warped. Damp spots appeared on the under side around the screw heads, showing that the water did not flow down in the shallow valleys between the corrugations. The ceiling was taken down and put up again, as shown on sheet No. 1. The old screw holes were plugged with solder. All the sheets required for one side were riveted into one piece, which was rolled up, carried into the magazine, hoisted, and secured in place. The angles running longitudinally, being spaced accurately on grade, hold the sheets well in line and form an easy passage for the water. The sheets lap for four corrugations and are riveted with two rows of one-eighth-inch tinned rivets. No leakage occurs around them. No signs of moisture appeared on the under side, whether from leakage or condensation. The side walls are covered with magnesia lumber sheets 36 by 46 inches by three-eighths inch. The lumber is magnesia building lumber and was purchased from Keasbey & Mattison Company for 24 cents per square foot. Each sheet is supported at four points by $1\frac{1}{4}$-inch brass screws, screwed into wooden blocks 2 inches in diameter and 3 inches deep, fastened with mortar in holes drilled in the wall. The method is as follows: First the walls were made clean by washing with water and brushing. The rooms were then thoroughly dried. The holes for the blocks were drilled into the concrete, and the blocks put in. After all the blocks were in place the walls were given a coat of hot asphalt mixture, which consisted of about 20 per cent coal tar and 80 per cent of asphaltum.

The coal tar was not constant in quantity, but was used on the same principle as oil in thinning paint. This gave a good mixture for working with brushes and mops, and no trouble was experienced in putting it on except that the fumes in the closed rooms were very stifling. Two coats were applied. As the second coat was applied the sheets were secured in place with the hope that the asphalt would assist in holding them in place, but after the asphalt cooled there was not much adhesion. Strips of tar paper were placed at the same time at the joints to prevent leakage of the asphalt through the joints, but they are of doubtful benefit. The water follows these strips and is transmitted to the sheets. At first the sheets were very damp and seemed to hold the water. The floor was damp, especially around the walls, as there were no drains to carry off the water. To aid in ventilating the room, two holes 6 inches in diameter were drilled through the wall to the air space. Drains were cut around the room next to the wall. The sheets underneath the ventilating holes are quite dry and the others are losing their moisture. The work has been too recently completed to judge of the efficiency of the magnesia lumber.

Emplacement No. 4.—Experience at other localities has shown that corrugated iron and lead have failed as roof coverings and that copper is the best metal to use. It was decided, therefore, to construct a ceiling such as is described in mimeograph No. 61, as used in Boston. There was on hand a supply of 20-ounce yellow metal and it was used instead of the copper. To prevent condensation the room was lined throughout with wood. The method is illustrated in sheet No. 2. The ceiling was built on trestles about 4 feet high. The yellow metal was

soldered together on top of the matched flooring, all holes being carefully filled. It extended about 3 inches over the longitudinal edges in order to be flared into the gutters which were cut into the longitudinal walls. There was a clearance of 1 inch between the ceiling and the concrete, which enabled the ceiling to be easily jacked into place and held in position by the 3 by 3 inch supports. The sides are lined with boards dressed on one side to make a neat appearance, but not driven closely together. This will allow for the swelling of the boards caused by the moisture condensing on the walls behind. The magazine is perfectly dry. The cost of the copper is more than the corrugated iron, but the ceiling is much easier to construct and the cost of labor is much less. The metal should last indefinitely. The wooden lining is especially easy to repair and is much cheaper than magnesia lumber or cork board. It is expected to use this method in other magazines. Copper sheets 3 by 8 feet, 16 ounces, will be used.

Emplacement No. 2.—This was one of the damp magazines. Before beginning work two holes 6 inches in diameter were cut through to the air space, being placed near the ceiling and on the side opposite the door. A decided change for the better followed. Condensation was largely decreased, but water still dripped from the ceiling in several places. The ceiling was lined with yellow metal and wood, as described for Emplacement No. 4. The wall will be covered with cork board, in sheets $35\frac{1}{2}$ by $8\frac{3}{4}$ inches by one-fourth inch, manufactured by the Nonpareil Cork Manufacturing Company, Bridgeport, Conn. The purpose of the cork is to prevent sweating on the walls, as cork is a poor conductor.

Emplacement No. 1.—The magazine is generally dry. There are no leaks, and very little condensation. There are few cracks in the top surface. Ventilating holes will be cut, and the money for lining the magazine will be held in hand in order to compare this naturally dry room with the others in which the ceilings have been put in.

MORTAR BATTERY.

The relocator room in the mortar battery is located at the end of a long corridor and has no ventilation except through the entrance door to the corridor, 100 feet away. The room has always been very wet. To catch the drip from percolation, a ceiling was constructed of No. 20 corrugated-iron sheets. A Z bar was fastened on each side of the room to the roof I beams by one-half by $1\frac{1}{8}$ inch tap bolts; the bars were 12 inches from the side walls. The sheets were fastened to the bars by one-fourth-inch stove bolts, and were curved so as to give a fall of 5 inches between the center of the room and the wall. Down spouts, 2 inches in diameter, conducted the water to the drains. The condensation since the ceiling was put up has been excessive. The room will have to be ventilated before it will be dry.

Closing cracks in top surfaces.—The cracks were cut out to a width of 2 inches and depth of 6 inches. After they were washed clean of concrete dust they were filled with boiled linseed oil. Generally they were filled two or three times, as the oil was absorbed. Hot asphalt was poured into the cracks. The film of oil causes good adhesion of the asphalt to the concrete. The top surface was covered with two coats

of the oil to stop the small cracks. It also colors the concrete—takes away the glare and causes it to blend with the landscape. Where sand surrounds the batteries this brownish color is more suitable than the green.

There has not been sufficient time to judge of the effect upon stopping leaks. The concrete was soaked with water, which must gradually pass away. The oiling forms an impervious coating on the concrete, and it is believed that repeated oiling will make the surface waterproof.

Three-inch battery.—The battery for two 3-inch guns has just been completed. It has three rooms which were surrounded on top, bottom, front, and sides with waterproofing, only the rear being omitted, as the rear wall is only 2 feet thick. The waterproofing was 85 per cent Seyssel rock asphalt and 15 per cent Venezuelan lake asphalt (bitumen), mixed with an amount of coal tar equal to 20 per cent of this bulk. Without the coal tar the mixture would not adhere to the vertical walls, as it was thick and stringy. The coal tar gave fluidity. The mixture had to be applied very hot. It was first applied to the side and front walls. The casing had been set out 1 foot beyond the finished dimensions of the room, and after removal the walls were plastered with a 1 to 2½ mortar. When dry a coating of asphalt mixture was applied with swabs made of old bagging tacked on handles. The wall was thoroughly coated. As a second coat was being applied one-ply tar paper was unrolled and applied vertically to the wall, being pressed into the hot asphalt. When the asphalt cooled there was little adhesion to the paper, and to keep it from peeling off it was fastened with carpet tacks. Two layers of paper and three of asphalt were applied. Enough paper was used to turn over at the top and bottom, connecting with the waterproofing on these surfaces. The casing was then set in to the proper size of the room, and the intermediate 1-foot wall of concrete put in. When the concrete over the top had been formed into an arch with about 1 foot height over the walls it was smoothed over with mortar and the paper and asphalt applied in the same way. On top of this a layer of thin mortar, 1 to 6, was placed to keep the broken stone of the superincumbent concrete from tearing the paper. The floor was put in last. The front surfaces against which the sand fill was placed were treated with a thick coating of the asphalt. A drain was laid at the foot of this wall with open joints protected with bagging, and a layer of broken stone was put between the concrete and the sand fill.

The vertical and horizontal surfaces exposed to the weather were finished with mortar, applied at the time of construction, mixed with soap and alum in the following proportions: One part cement, 2½ parts sand, three-fourths pound powdered alum to each cubic foot of sand, mixed dry. This was wet with the proper amount of water, to which three-fourths pound of soft soap per gallon had been added. This mixture gives a yellowish tinge to the concrete, and if not carefully mixed it will be streaky.

Very respectfully,

G. P. Howell,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

FORT HAMILTON, NEW YORK.

SKETCH SHOWING

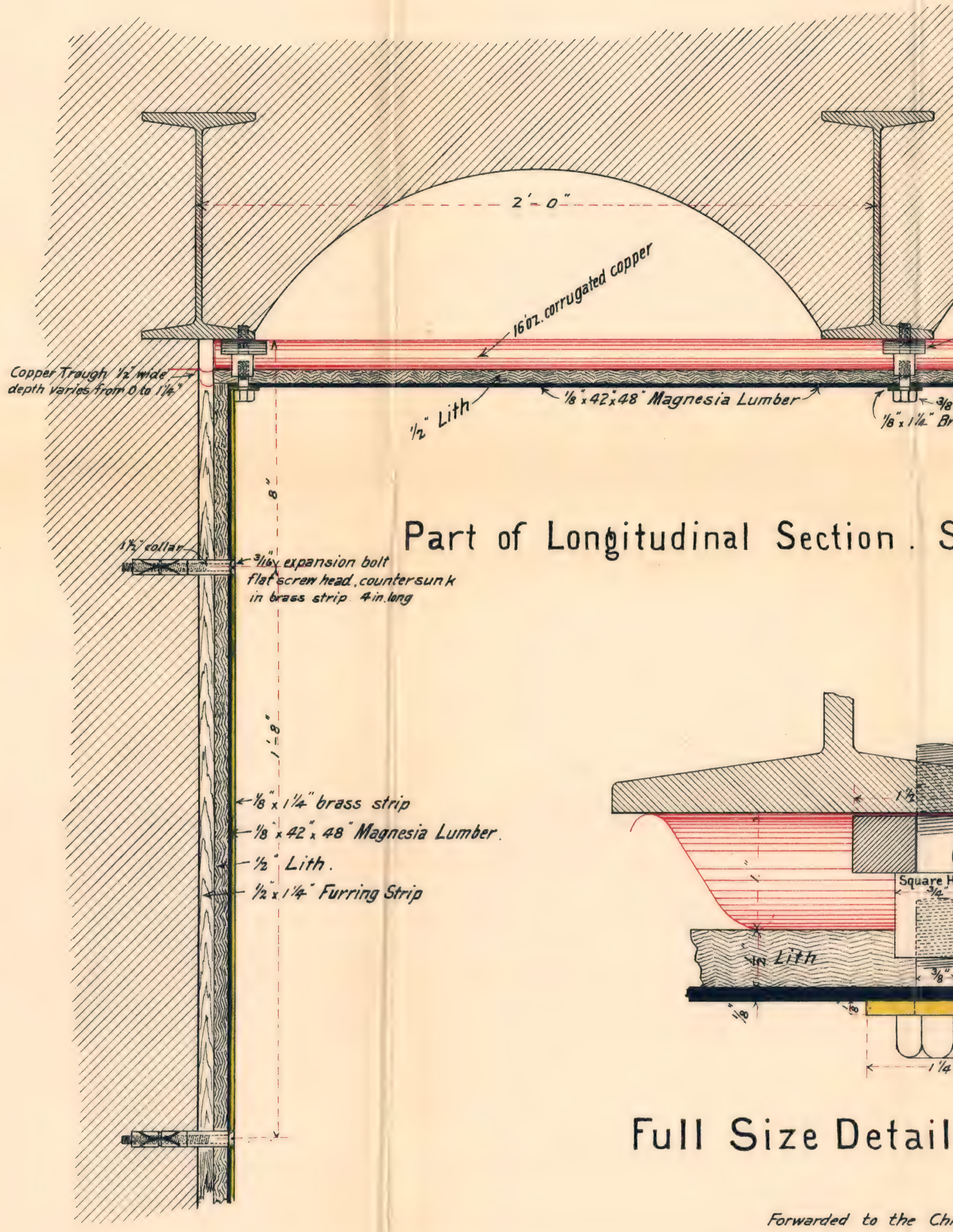
DAMP-PROOF LINING OF CORRUGATED COPPER, LITH AND MAGNESIA LUMBER, IN CARTRIDGE ROOM, EMPLACEMENT No. 7, 10 Inch BATTERY.

drawn under direction of

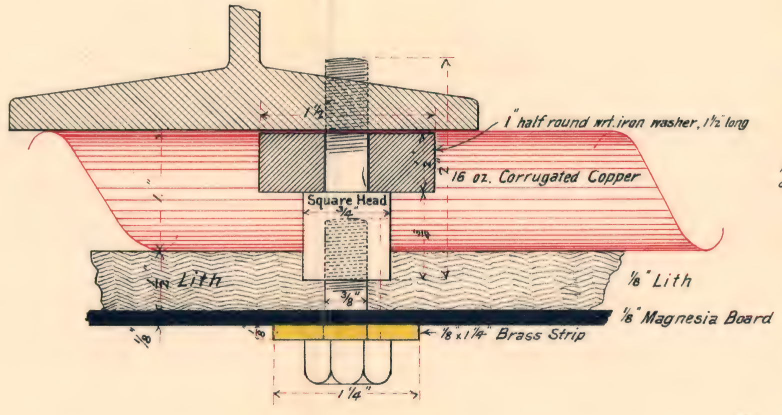
MAJOR W. L. MARSHALL, CORPS OF ENGINEERS, U.S.A.,

DESIGNED BY G. W. KUEHNLE, ASST. ENGR.

FEBRUARY 1903.



Part of Longitudinal Section. Scale ¼.

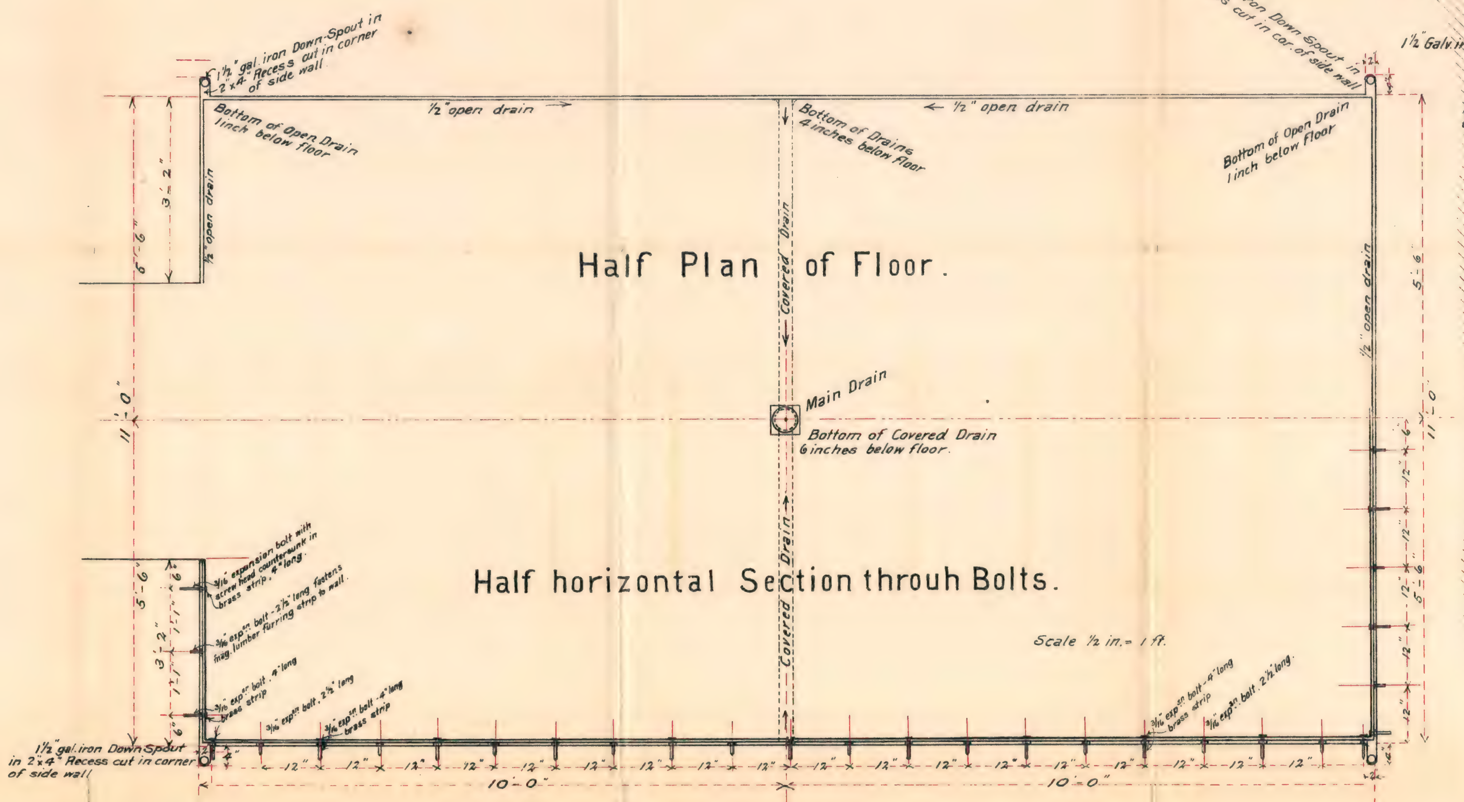


Full Size Detail of ⅜ in. Tap Bolts.

Forwarded to the Chief of Engineers, U.S.A., with report dated September 5, 1903.

W. L. Marshall

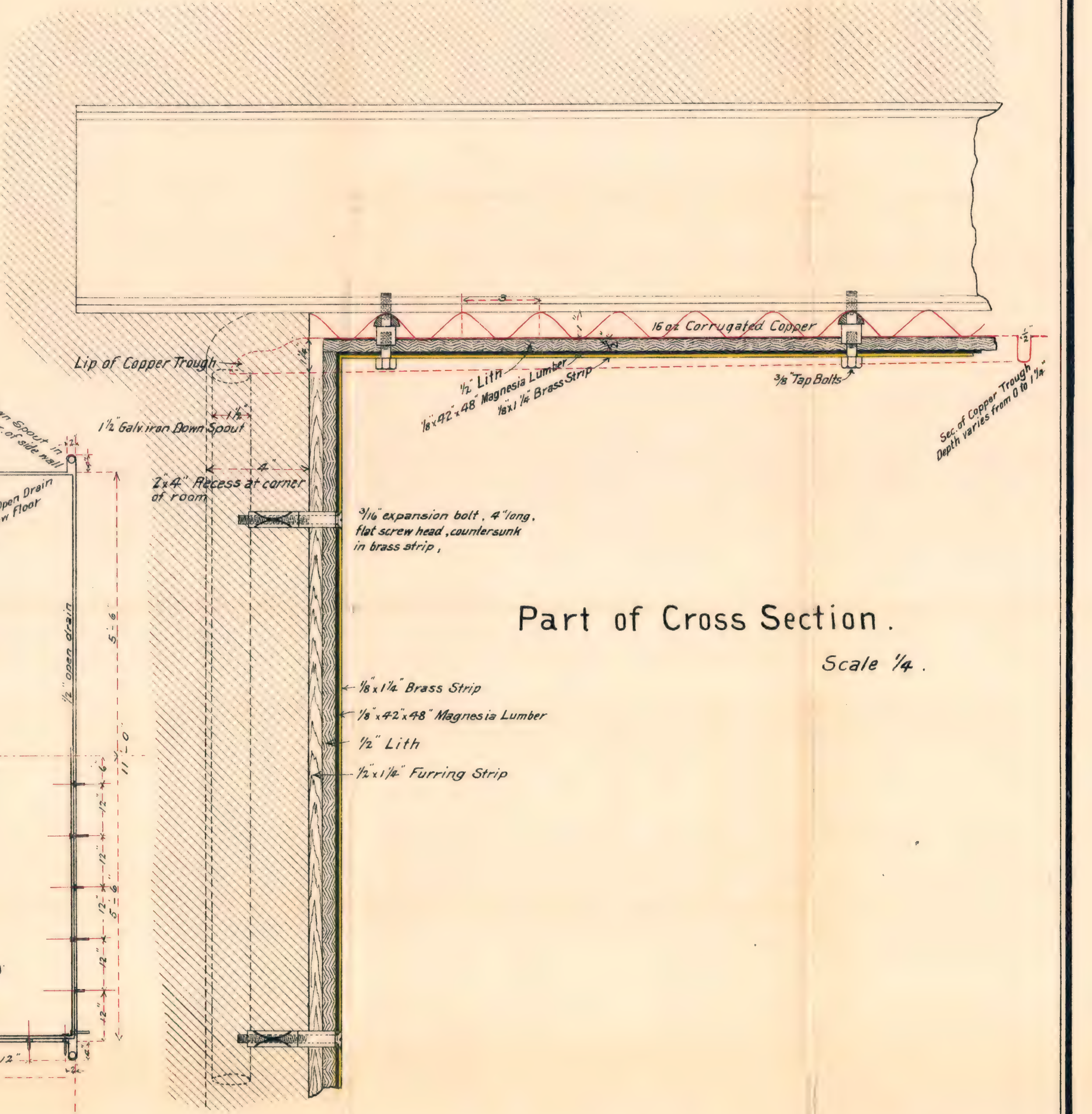
Major, Corps of Engineers, U.S.A.



Half Plan of Floor.

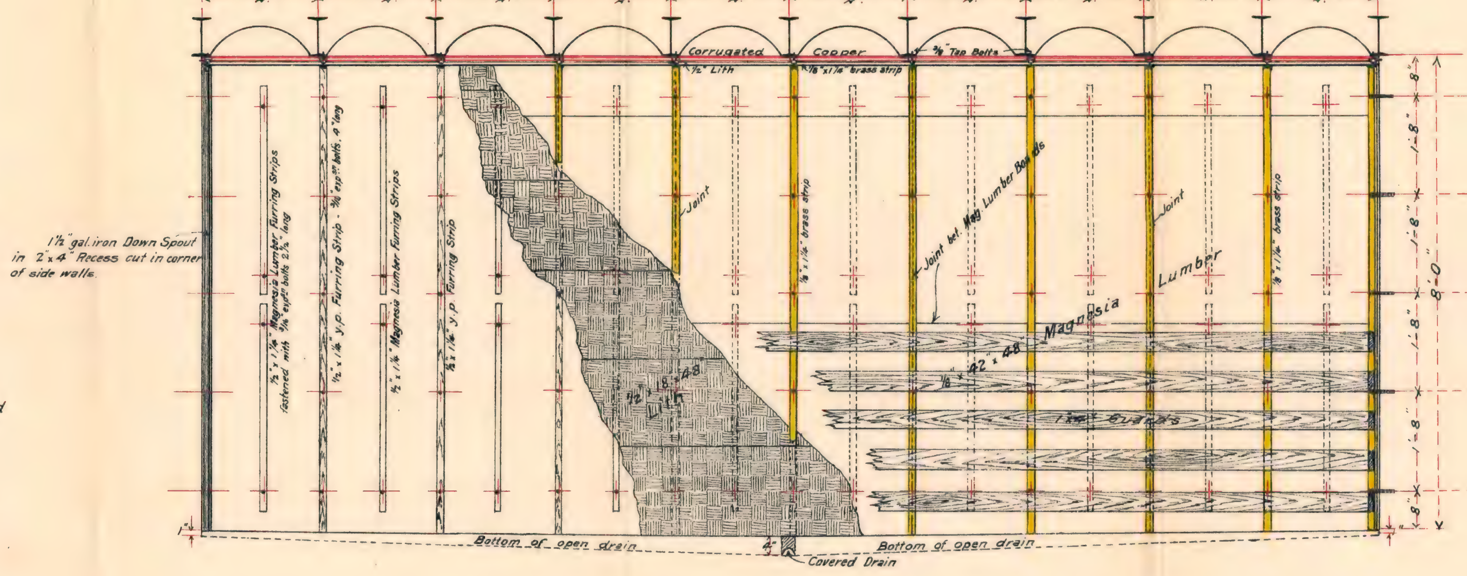
Half horizontal Section throuh Bolts.

Scale ½ in. = 1 ft.



Part of Cross Section.

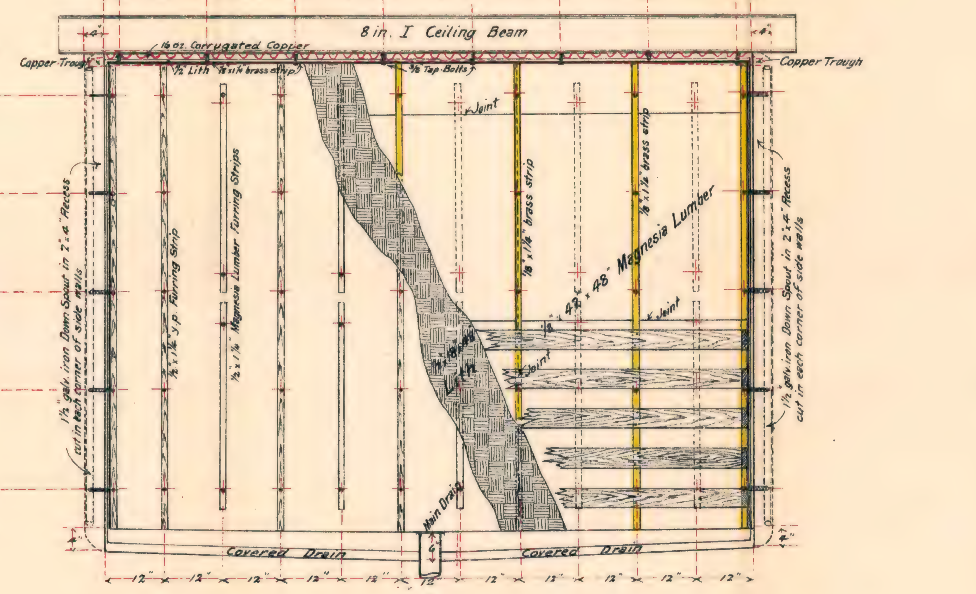
Scale ¼.



Longitudinal Section and Elevation of Side Wall.

Scale ½ in. = 1 ft.

Yellow Pine Furring Strips are coated with Bitumen.



Cross Section and Elevation of Rear Wall.

Scale ½ in. = 1 ft.

Drawn by C. G. Auerbach.

Eng 581

B B B 10.

DEFENSES OF COAST OF FLORIDA AT KEY WEST AND TAMPA.

[Officer in charge, Capt. Francis R. Shunk, Corps of Engineers.]

1. General: There has been no trouble from condensation in this district. Such leakage as has occurred has been due to various causes.

2. In the old work, built by contract, cracks have developed in the mass of concrete. These have caused very bad leaks. The only successful method of treating these leaks has been to build an inner room, with metal roof and brick side walls. The accompanying sketches show the construction used—where there are no trolley rails in the room, pl. 1; where there are trolley rails in the room, pl. 2.

If the leak is a very small one, a sheet of metal may be attached to the ceiling beams, so as to inclose the leak, a pipe connected with the sheet and led to the nearest drain.

3. In some of the works moisture has entered through fine horizontal cracks, probably between successive layers of concrete. These cracks are sometimes so fine as almost to escape detection, but nevertheless allow a great deal of leakage. They have been successfully treated as follows: The upper edge of each crack is carefully chipped away and a small gutter formed, which is floated with boiled linseed oil twice a week for two months. The entire outer surface is then chipped away and a coat of plaster carefully applied. It may very well be that the plastering alone would stop the leaks.

4. Such horizontal cracks have occurred only where the outer coat of mortar has been placed inside the forms as the work progressed. The plan now followed is to defer the plastering until the forms have been removed. Great care must be taken thoroughly to saturate the surface to be plastered. After this a coat of thick grout is applied with a brush. When this has received its initial set the plaster is applied, firmly pressed into place, and brought to a smooth surface, preferably with an iron float. No surface treated in this manner has leaked.

5. To prevent percolation through the mass of concrete the method used in new construction at Key West, Fla., is as follows: The side walls are completed and about 2 feet of concrete placed over the roof. The side walls are then plastered outside with Portland cement mortar. Various proportions have been used, from 1 cement and 1 sand to 1 cement and 3 sand. These have been equally satisfactory, and 1 to 3 mortar is now used. The roof is finished on top with one-half-inch Portland mortar, placed immediately after the concrete is laid and brought to a grade of about 1 in 50. A layer of asphalt is then spread over the mortar surface. The asphalt is composed as follows: Asphalt mastic, 440 pounds; coal tar, 3 gallons; siliceous sand, 5 gallons. Over this is placed a layer of mortar, in order to prevent the stone in the overlying concrete from cutting into the asphalt. When this has set the remaining concrete is added. When possible a 6-inch air space is left in the walls around the rooms, and drains are placed in the air space to drain the water outside of the walls. The air spaces are covered with brick and the asphalt extends over the bricks. This method has been very successful. There is reason to believe, however, that the layer of asphalt is not necessary. At Tampa some of the rooms

are protected by a layer of asphalt; others are not. The outer surfaces of the latter, both side and top, were carefully plastered, as described in paragraph 4. They are perfectly dry. The like is the case at Battery Burchsted, where the rooms of one emplacement are protected by asphalt, the others plastered; they are equally dry.

In a few instances in the old work at Key West percolation, apparently not due to cracks, has taken place. Such cases have been treated as follows: The outer surface of the concrete through which percolation has taken place was covered with asphalt in two layers, making a thickness of three-fourths inch. The asphalt was then laid in Rosendale mortar, given a good slope for drainage, and carried to the vertical walls outside of the air spaces. This method was successful when the surface thus treated was afterwards covered with sand. It was not successful where the surface was left exposed to the weather. In future such cases will be treated by plastering, as described in paragraph 4.

Respectfully submitted.

FRANCIS R. SHUNK,
Captain, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 11.

DEFENSES OF MOBILE, ALABAMA.

[Officers in charge, Capt. Spencer Cosby and Capt. W. E. Craighill, Corps of Engineers.]

GENERAL:

* * * * * * *

The 8-inch battery built between 1895 and 1898 has some magazines which have given trouble from leaking. Various methods of lining have been tried and described in previous reports.

During the past year a new type of roof for the interior lining was designed and put into several of the rooms of the battery toward the end of the fiscal year, so late that there has not been time to see whether or not it is entirely successful. The purpose of the design is to permit the roof of the lining to be removable. A drawing showing the details accompanies this report.

Linings of this character were installed in the powder and shell rooms of emplacement No. 2, in the shell room of emplacement No. 3, and in the powder room of emplacement No. 4. The linings consist of brick side walls with air space behind, and a copper ceiling supported by tongue-and-groove lumber, the bottom of which is faced with asbestos millboard and tacked to the wood. All wood and iron work was painted white. Drains from the air spaces behind were led into the rooms, so as to be more readily cleaned. The lower course of brickwork was treated by the Sylvester process, in order to render it impervious to moisture. The ends of the brick projecting into the air space were treated in the same manner.

The ceilings are made in sections, and so arranged that they can be taken down and examined without disturbing the brickwork. The

thin asbestos millboard has shown a tendency to mildew, and to the touch resembles damp blotting paper. As work was only finished after the 1st of July, and as the brick were soaked with water, it may be that it is too soon to say whether or not the use of the asbestos lining is desirable.

Respectfully submitted.

W. E. CRAIGHILL,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 12.

DEFENSES OF NEW ORLEANS, LOUISIANA.

[Officer in charge, Lieut. Col. H. M. Adams, Corps of Engineers.]

GENERAL: Complying with the provisions of General Orders, No. 5, Headquarters Corps of Engineers, current series, I have the honor to submit a report on the methods applied to stop percolation and to lessen condensation in the magazines of the modern batteries at Fort St. Philip, La. It is not believed to be necessary to delay this report one month after the rendition of the annual report, as indicated in General Orders, No. 5, as the effects of these methods have already been observed.

The magazines of all the modern batteries at Forts St. Philip and Jackson have always been practically free from percolation except the magazines of one 8-inch battery and one 10-inch battery.

Water formerly dripped from the ceilings of the magazines of the 8-inch battery for several days after a rain. The magazines were lined with 13-inch brick walls, leaving an air space between the concrete and brick walls. The walls were strengthened by iron anchor bolts embedded in the concrete, and also by occasional bricks touching the concrete.

The ceilings were lined with sheet lead, weight 4 pounds to the square foot, except in one relocator room, where 16-ounce sheet copper was used. The sheet lead and copper are held in place by brass expansion bolts spaced 2 feet apart.

In settling this battery tilted forward, so that the ceilings slope to the front, and all water from the ceilings drains forward to the air spaces. Gutters were built at the bottom of the air spaces draining to the rear of the battery.

The ceilings were lined first. Holes were drilled into the concrete in rows 2 feet apart, and the expansion bolts were cemented into place.

A platform was constructed about halfway between the floor and ceiling, with boards left out where the expansion bolts were to be applied. The sheet lead was spread out on the platform and all seams were soldered. Jacks were then placed under each corner of the platform, and the platform was raised up tightly against the ceiling. A chalk line was then snapped against the lead to locate the expansion bolts. The screws were inserted and the platform was removed. Wherever leakage appeared around a screw head, the screw head was soldered to the lead.

In the gallery, where there was not sufficient width for brick walls, the walls were lined with sheet copper, held in place in the same manner as the ceilings.

The magazines of the 8-inch battery are now free from percolation. A drawing is submitted, showing the details of the lining of these magazines.

In accordance with instructions of the Chief of Engineers, the powder magazine of No. 2 10-inch battery was lined with asbestos lumber in order to test its efficiency in preventing condensation. The walls and ceilings were lined with this lumber held in place by brass screws screwed into wooden plugs firmly driven into holes drilled into the concrete. The ceilings and walls were heavily coated with asphalt. The ceiling was then lined with 16-ounce sheet copper, and the walls were lined with "Paroid" felt, after which the asbestos lumber was applied.

No leakage or condensation has appeared in this magazine since the lining was applied. A drawing showing the details of the lining of this magazine is forwarded herewith.

Very respectfully, your obedient servant,

H. M. Adams,
Lieutenant-Colonel, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

B B B 13.

DEFENSES OF GALVESTON, TEXAS.

[Officers in charge, Capt. C. S. Riché and Capt. Edgar Jadwin, Corps of Engineers.]

General: I have the honor to forward herewith reports of Supts. W. A. Hinkle and S. W. Campbell on the methods employed in this district to stop percolation and lessen condensation.

There is still considerable leakage in the high-power batteries. There is not much condensation at this time of year, but I am informed that there is during the winter months.

Very respectfully,

Edgar Jadwin,
Captain, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

REPORT OF MR. W. A. HINKLE, SUPERINTENDENT.

Captain: I have the honor to report as follows in accordance with Circular No. 23:

There has been nothing done during the year ending June 30, 1903, to stop percolation or condensation in any of the batteries under my charge except it might be the filling of cracks in loading platform of one gun at a battery for two 8-inch guns. This was done by cutting a V-shaped groove wherever a crack developed and filling same with heavy asphalt gum. The V-shaped groove is about three-fourths i[illegible] [illegible] width on surface and about one-half to three-fourths inch deep. The watchman at this battery reports very little leakage since the asphalt was put in. I was at this

FORT WADSWORTH, NEW YORK,

SKETCH SHOWING
DAMP PROOF LINING OF WOOD AND CORK
IN
SHELL ROOM.

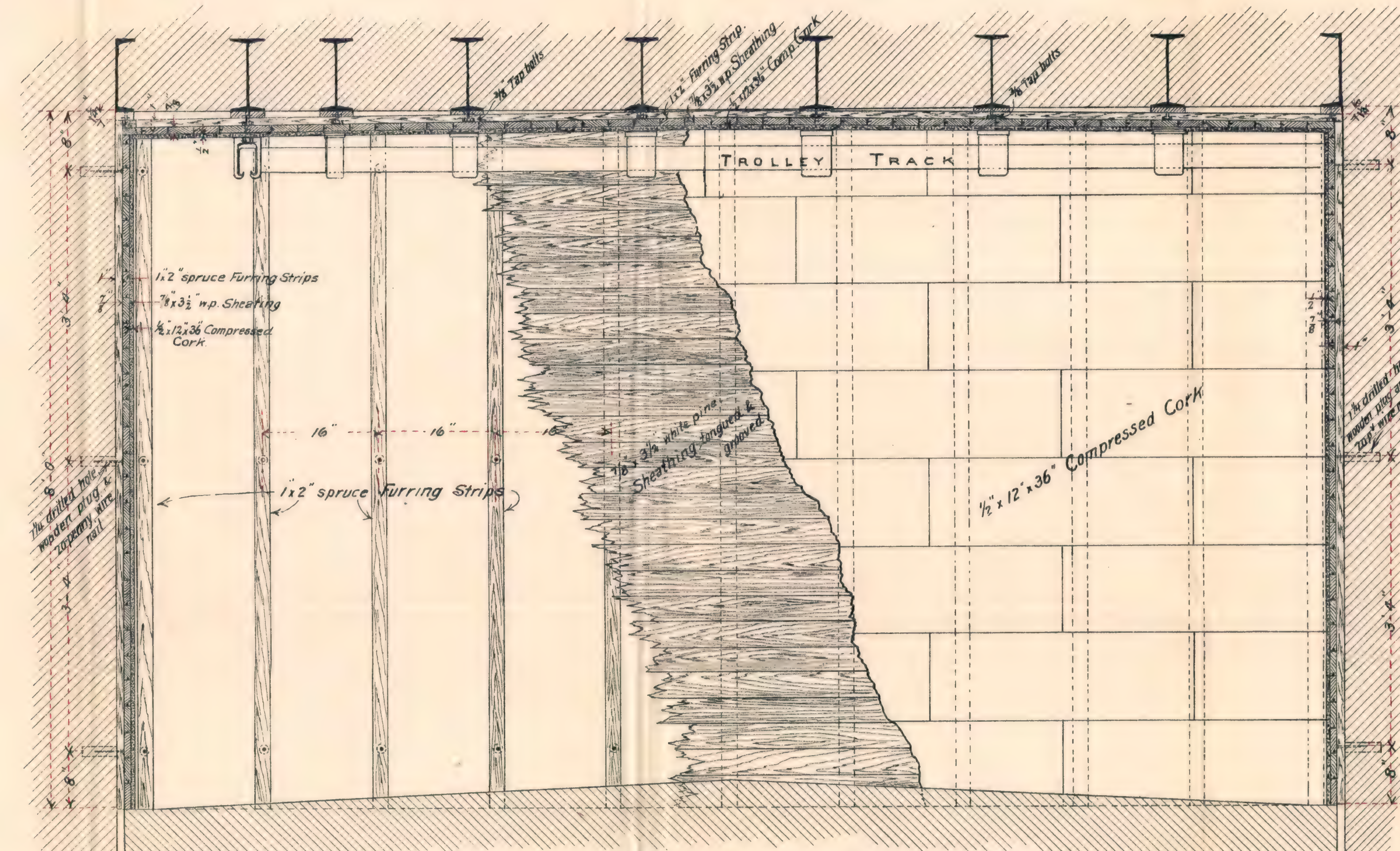
drawn under direction of

MAJOR W. L. MARSHALL, CORPS OF ENGINEERS, U.S.A.,

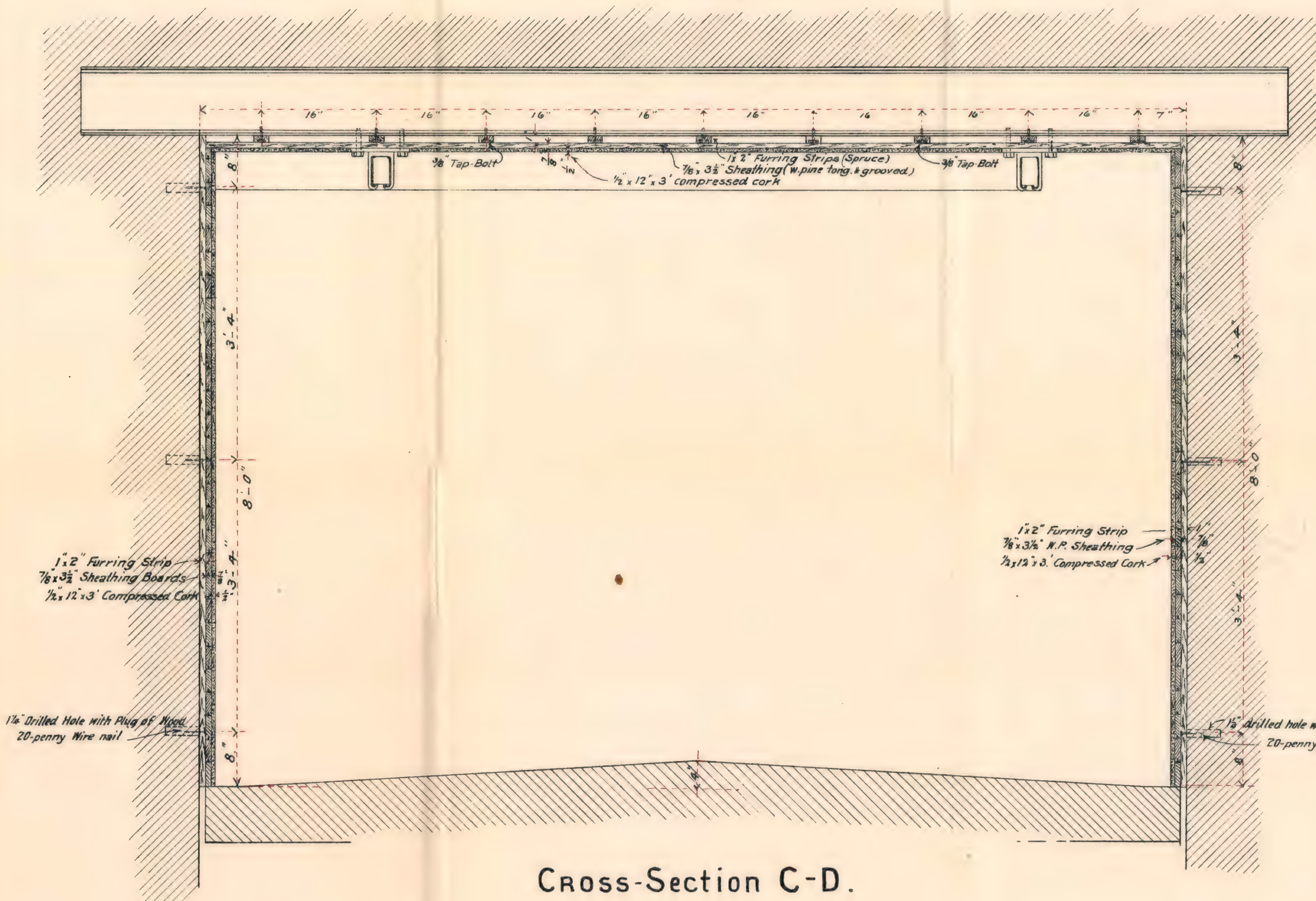
Designed by JOHN A. YATES, Ass't Eng'r.

FEBRUARY 1903.

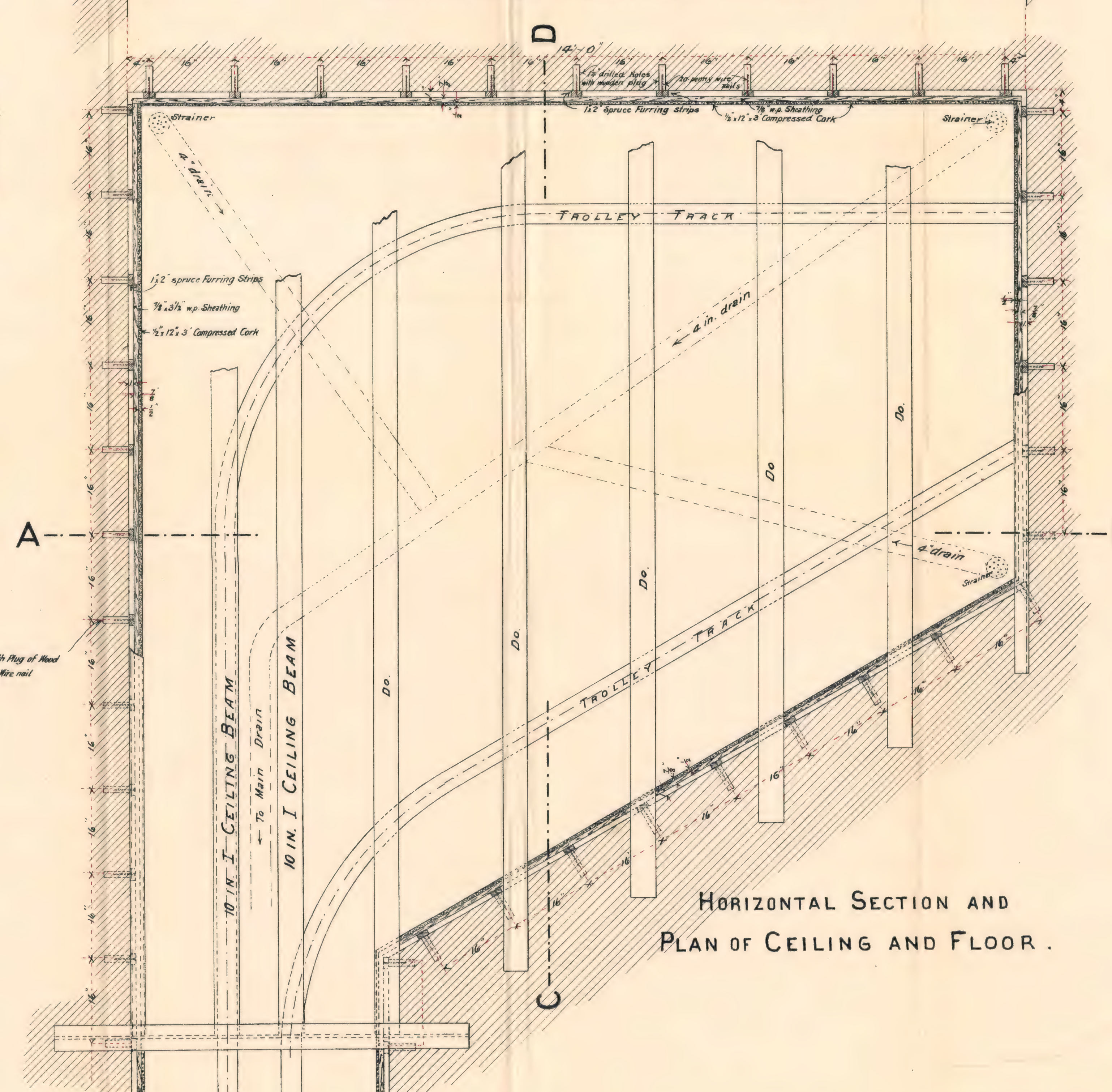
SCALE, ¾ IN = 1 FT.



SECTION A-B & ELEVATION OF REAR WALL.



Cross-Section C-D.



HORIZONTAL SECTION AND
PLAN OF CEILING AND FLOOR.

Forwarded to the Chief of Engineers, U.S.A., with report dated September 5, 1903.

W. L. Marshall

Major, Corps of Engineers, U.S.A.

FORT HAMILTON, NEW YORK

SKETCH SHOWING

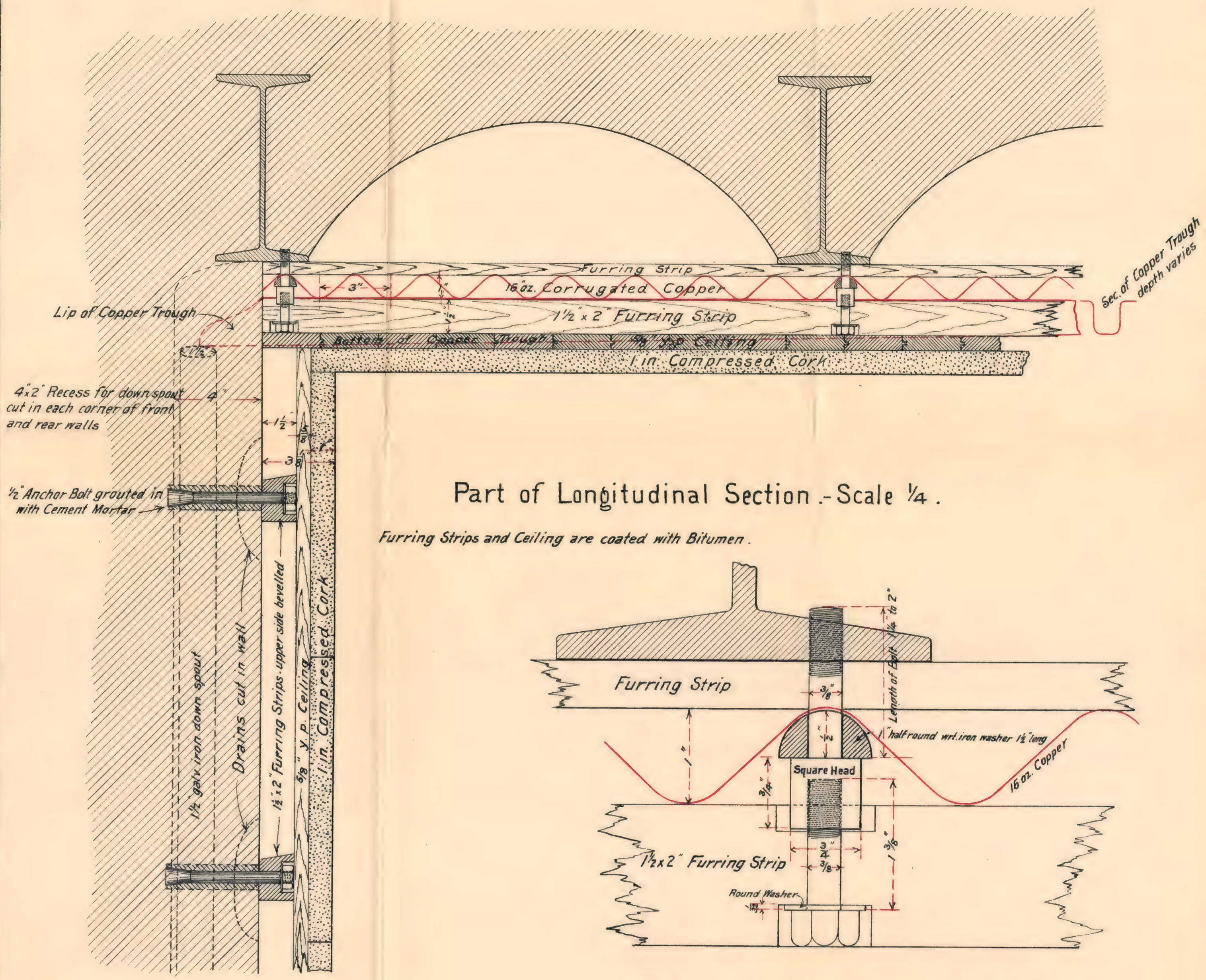
DAMP-PROOF LINING OF CORRUGATED COPPER, WOOD AND CORK, IN CARTRIDGE ROOM, EMPLACEMENT No. 6, 10-Inch BATTERY.

drawn under direction of

MAJOR W. L. MARSHALL, CORPS OF ENGINEERS, U.S.A.

DESIGNED BY G. W. KUEHNLE, ASS'T ENGR.

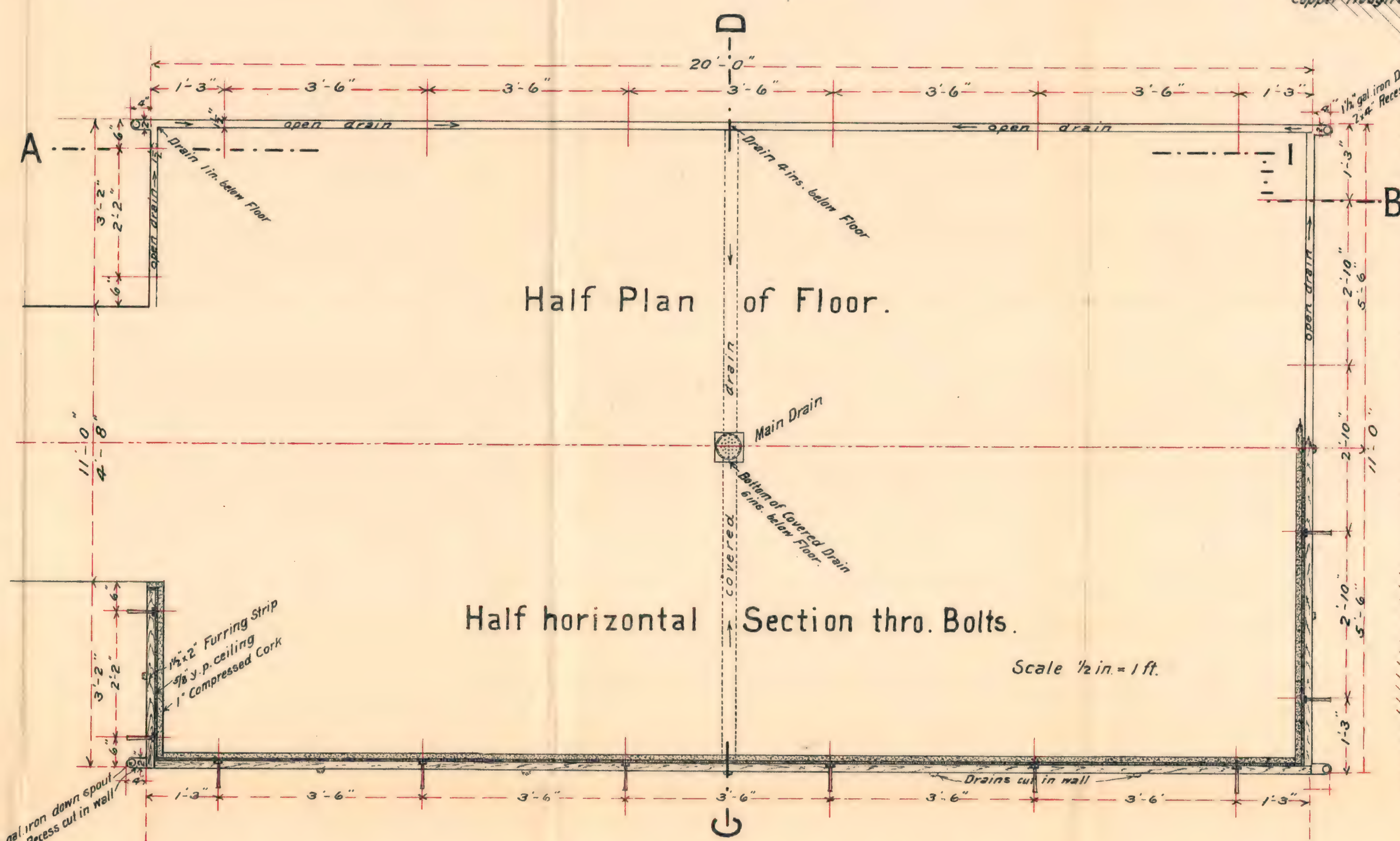
FEBRUARY 1903.

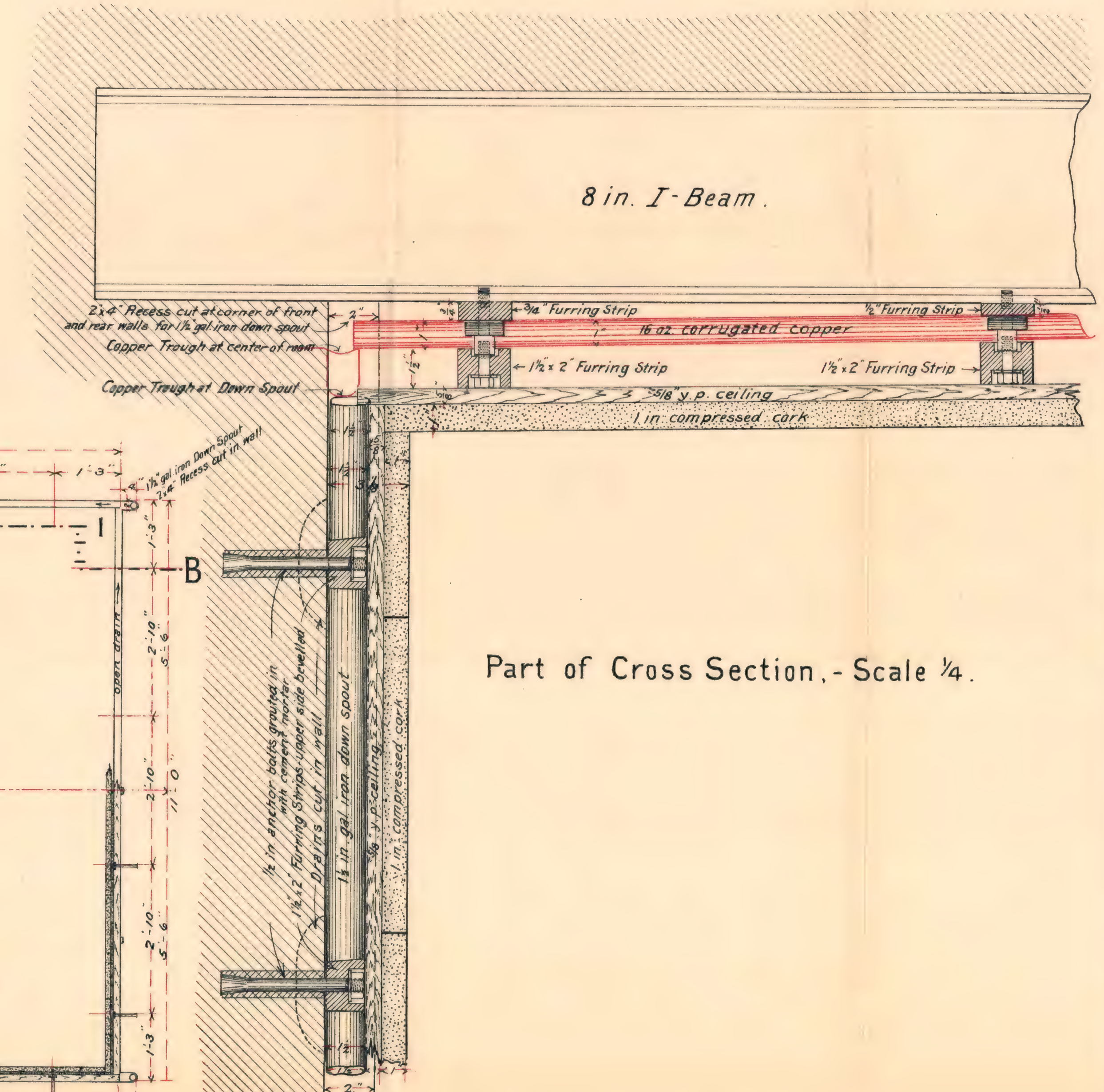


Part of Longitudinal Section. - Scale ¼.

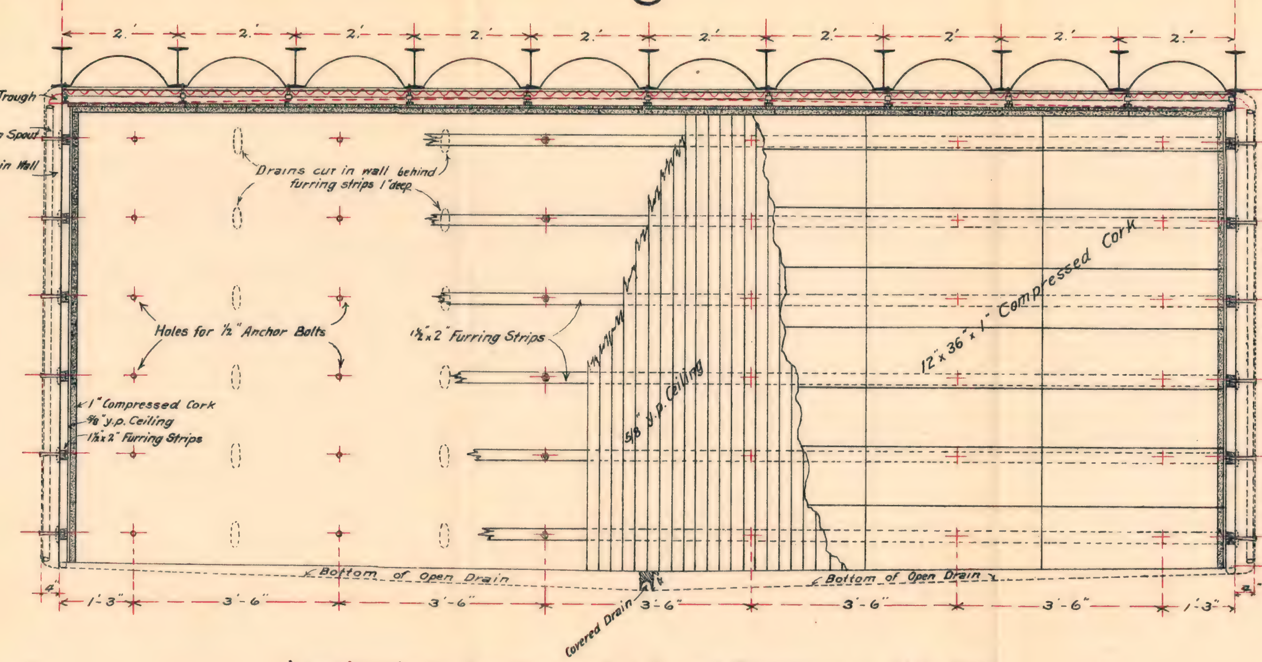
Furring Strips and Ceiling are coated with Bitumen.

Full Size Detail of ⅜ in. Tap Bolts.



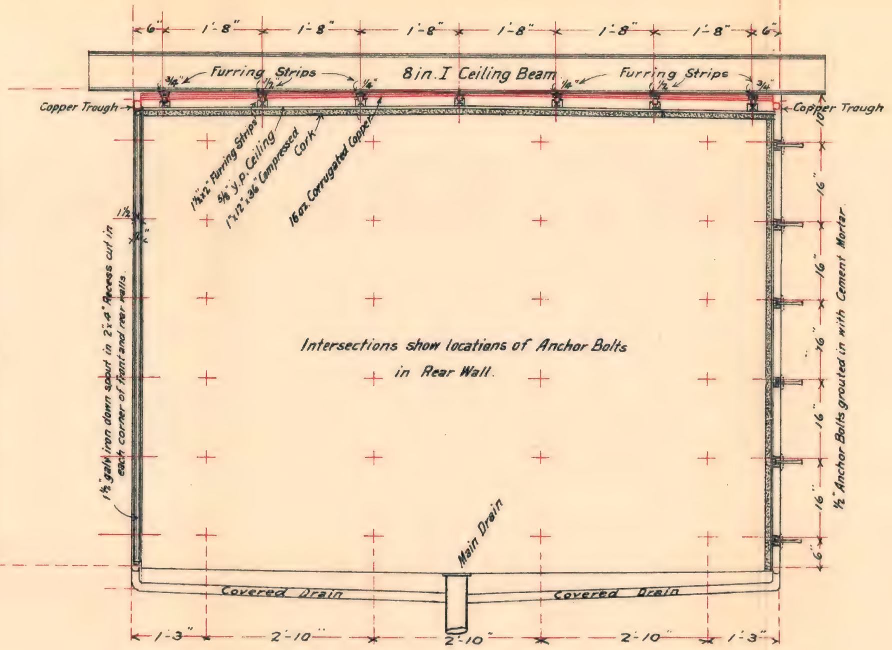


Part of Cross Section, - Scale ¼.



Longitudinal Section on A, I, B, and Elevation of Side Wall.

Scale ½ in. = 1 ft.



Cross Section C-D.

Scale ½ in. = 1 ft.

Forwarded to the Chief of Engineers, U.S.A., with report dated September 5, 1903.

W. L. Marshall

Major, Corps of Engineers, U.S.A.

Drawn by C. G. Auerbach.

Eng 58 1

battery in May, 1903, during a heavy rain and no leaks were observed during my stay of some two or three hours.

In the early part of the present month the watchman reported a slight leak during a heavy rain. During foggy weather, say from January to April, the condensation in magazines and in entire inside of battery is very bad. No attempt has been made to remedy condensation. Captain Riché's idea was to hold this matter until all reports from other localities were in and then adopt the most successful method.

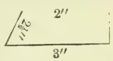
Very respectfully, your obedient servant,

W. A. HINKLE, *Superintendent.*

Capt. EDGAR JADWIN,
Corps of Engineers, U. S. Army.

REPORT OF MR. S. W. CAMPBELL, SUPERINTENDENT.

CAPTAIN: I have the honor to submit the following in regard to method employed in stopping leaks in a 10-inch battery: A channel was cut along the joints of blocks on the loading-platform level, also a few on top of battery. The channels were cut 2 inches wide on top, 3 inches wide at the bottom, and $2\frac{1}{2}$ inches deep, viz: the bottom covered one-half inch deep with Stockholm tar, then filled with mortar of 1 cement to 1 sand. This only proved satisfactory during cool weather, for during the heat of present summer the tar has been forcing out and battery leaking same as before in four or five places.



Very respectfully, your obedient servant,

S. W. CAMPBELL, *Superintendent.*

Capt. EDGAR JADWIN,
Corps of Engineers, U. S. Army.

B B B 14.

DEFENSES OF SAN FRANCISCO HARBOR, CALIFORNIA.

[Officer in charge, Lieut. Col. Thomas H. Handbury, Corps of Engineers.]

[Report of Assistant Engineer J. H. G. Wolf.]

FOUNDATIONS AND FOUNDATION BEDS.

Where battery sites in this harbor are on elevated positions, they are generally located on ridges where the foundation material is usually rock or shales tending to rock. An exception to this rule was found at the 12-inch disappearing gun battery at the point where most of the work has been concentrated the past few years. The site is elevated, but the surface dipped back from the face of the cliff, and the rock was about parallel with the surface, but 40 feet and more below. The soil overlying the rock was for the most part light-yellow clay, while some portions of it were a sandy clay. When excavated and placed in a spoil bank it settled 20 per cent and more, and it has since given a good deal of trouble where deposited as backfill on the right flank of the battery. Manifestly a foundation bed of that character could not be depended upon to carry safely the loading designed for the work, the greatest being a concentrated load of about 30 tons per square foot. The entire area therefore was excavated to the grade of the bottom of the gun platforms, or about 3 feet 6 inches below the service room floors, and refilled with Portland cement concrete (the only cement used for concrete on local works; it was mixed 1:3:8). No iron or

steel work was added to lessen the quantity of concrete, for the reason that there were no old rails on hand, nor could any be obtained in the market cheaply at the time. The course taken proved to be a good precaution, for not only was concreting prosecuted all through the winter months with perfect safety, but no appreciable settlement has since been detected anywhere in the emplacements. The planes between the different masses of masonry, to allow for expansion and contraction, were taken only to the floor level.

Fine dry sand, compacted, has proven a splendid foundation bed at the mortar battery. In beginning concreting, a footing course of 10 inches of concrete was placed over the magazine area, which area was shaped something like the letter H. The footing course constituted the floor of the rooms. This concrete floor was placed in hot weather, and the natural action of expansion and contraction soon broke it into three main masses. The cracks came where the two vertical sections were joined by the horizontal. A crack also appeared along the middle line of the horizontal section, possibly because a slight depression, for 3 feet in width, had been left there in which, later on, to place the track for the powder cars. When building the superstructure the mass was divided into three sections about on the lines where the cracks in the foundation appeared. The completed work, after standing nine months, shows not the slightest sign of a check or crack anywhere. The lines of junction between the respective masses can not be found in the galleries by a most critical examination. The range of temperatures in a mortar-battery magazine, when covered with 10 feet of sand fill, is slight; hence little or no expansion and contraction have occurred, nor has any settlement taken place even on so slight a foundation as 10 inches of concrete.

CONCRETE PLANT.

The concrete plant for the batteries at the point where most of the work has been concentrated is described in the Annual Report, Chief of Engineers, 1901, page 863, and in the Report for 1902, Appendix Z Z, page 2472.

The mixing plant has remained in its one position, at the 12-inch emplacement, for the construction of three other batteries. The quarry was extended to the westward during the year, so as to open up a new ledge of stone. The quality of the stone has remained uniformly good; not more than 15 per cent of what is blasted from the face is wasted. The shaft of the No. 5 Gates crusher broke during the year, and when replacing it a corrugated crushing head was substituted for the smooth head. No further trouble has been experienced from this source. The corrugated head gives the better service.

In the light of the experience gained in using a crushing plant without a screen while concreting with the "run of crusher," it is found desirable to install a first-class revolving screen. Making use of all the material from the crusher produces splendid concrete, but the ordinary workmen on the mixer platform can not be trusted to vary the proportion of sand to accommodate the different grades of crushed stone as the stone comes from the storage bin. Hence it is better to provide screens and suitable bins. Concrete, mixed in cubical mixer with just enough water added to make it mealy, has been hauled from one-fourth to one-half miles in four-horse wagons to three different batteries and there deposited. After reaching the batteries more water was added as it was being shoveled into barrows. No evil effects were

observed in the concrete by conducting the work in this manner, and it saved rearranging plant several times. It was cheaper to haul over the concrete than to haul each ingredient separately, particularly since iron tramways, with steam power, were used to transport the stone and sand to the mixing platform.

WALLS AND ROOFS.

All outside walls of the magazines and the parapets are made of concrete mixed 1:3:8. Bowlder stones have been embedded in these to the height of the ceilings. The concrete was deposited in layers 6 inches thick, the beds of which slope to the front on an incline of about 1 in 20. It was similarly deposited in the roofs, where the concrete was made slightly richer in fine material and in cement; no bowlder stone was placed in either roofs or bearing walls—walls supporting beams. The steel work to carry the masonry of the roofs (placed 6 inches above the ceiling of the rooms) has heretofore been I beams. A late mimeograph from the Office of the Chief of Engineers on the subject of rapid-fire emplacements permitted the use of twisted steel bars instead of beams, and this has been adopted as being much cheaper. A room of 12 feet width, the ceiling of which was supported in the new way by three-fourths-inch twisted steel bars spaced 1 foot centers.

No extended use has been made of hollow tile placed vertically in the walls, excepting in 12-inch emplacements. The service rooms and shot galleries under the loading platforms are separated from the gun blocks by 6-inch tile. The 2-inch tile placed in the ceiling pitches from all sides into the wall tile.

The use of a waterproofing course of tile, laid horizontally in the loading platforms, has proven a good measure. The concrete was brought up over the ceiling beams, floated to a fairly smooth surface, with planes pitching into the 6-inch vertical tile. When dried out somewhat, a layer of three-ply roofing felt, laid with asphalt and coal tar, was spread over the surface. Upon the latter was placed 2-inch tile. The concrete over the tile was from 10 to 18 inches thick. In the width of each platform (about 60 feet) it has broken into four distinct, irregular-shaped masses, on lines radiating from the circular steps of the gun platform. The cracks have gone no farther than the tile. There has been no sign of moisture in any of the rooms during the past two winters, excepting at one point where the platform, in joining the traverse, was not properly constructed. The fault has since been corrected.

As the emplacements recently built at this point have been dry in every room and gallery, the concrete of the walls and roofs has been proof against percolation, and since there is no condensation whatever in emplacements in this harbor, absolutely dry rooms, magazines, and galleries have been obtained.

CLEANING IRON AND PAINTING.

The position of some batteries on high ground overlooking the water causes them to be in the fog much of the time. The salt-laden air deposits its moisture on the doors and other exposed ironwork in such quantities that no protective coating is proof against it for more than a year. Exposed points, such as angles and rivet heads, give way first, and gradually the whole surface crumbles. No matter how skillfully the doors were cleaned with scrapers and steel brushes before erecting, a truly bright surface was never obtained, and could not be obtained.

This was considered to be the prime cause for early rusting; hence, when during the year a sand-blast plant was purchased to clean gun carriages which had arrived from the East in poor condition, the use of the blast was extended to cleaning all ironwork about and in the batteries. The plant will first be described. A sketch of the sand hopper is given on the accompanying drawings, Pl. I.

It consists of a horizontal 6 by 6 by 6 inch steam-driven air compressor, with a common kitchen boiler, 12 inches in diameter, as the air-receiving tank. The sand hopper is a kitchen boiler 20 inches in diameter and about 60 inches high. In the dome of the boiler the flanged opening which was intended to admit the water connection was enlarged to 3 inches, and a 3-inch plug was screwed in. This opening served when charging the tank with sand. At a point about 20 inches above the concave bottom a cone-shaped hopper was inserted and riveted to the inside of the tank; the point of the cone was about 1½ inches in diameter, and to it was riveted a piece of 1¼-inch water pipe with a slit opening one-fourth by 1¾ inches, looking upward into the sand tank; the 1¼-inch pipe was 20½ inches long, piercing the tank from one side to another, and it constituted the barrel of the valve mechanism; the valve-stem end terminated with a stuffing box and the delivery end with the one-half-inch sand-delivery hose. The valve was merely a hollow piston 1¼ inches outside diameter, about 4 inches long, with a slot one-fourth by 1¾ inches on the upper side corresponding to the aperture in the enveloping cylinder. In operation the valve is drawn inward or outward to regulate the quantity of sand. The air pipe, 1 inch in diameter, is from 200 to 300 feet long, giving a good working radius; the nozzle is of hardened steel, quite heavy, as it wears considerably; the tips are three-sixteenths-inch tube steel, about 1 inch long, and when hardened in nitrate of silver and wearing to three-eights-inch diameter will last from two to three hours each. It is found best to operate with an air pressure of from 25 to 30 pounds. The first outlay for compressor, sand tank, and hose (omitting the air pipe), including the erection of the plant, was about $400, of which $265 is charged against the compressor. The Rix Engineering Company, 396 Mission street, San Francisco, Cal., devised the sand hopper and supplied the plant.

After six months of running, more or less steadily, the plant is considered a very satisfactory investment. It cleans the sheet-steel work, such as doors, at a cost of from 4 to 5 cents per square foot, in a manner which no hand labor can do at any cost.

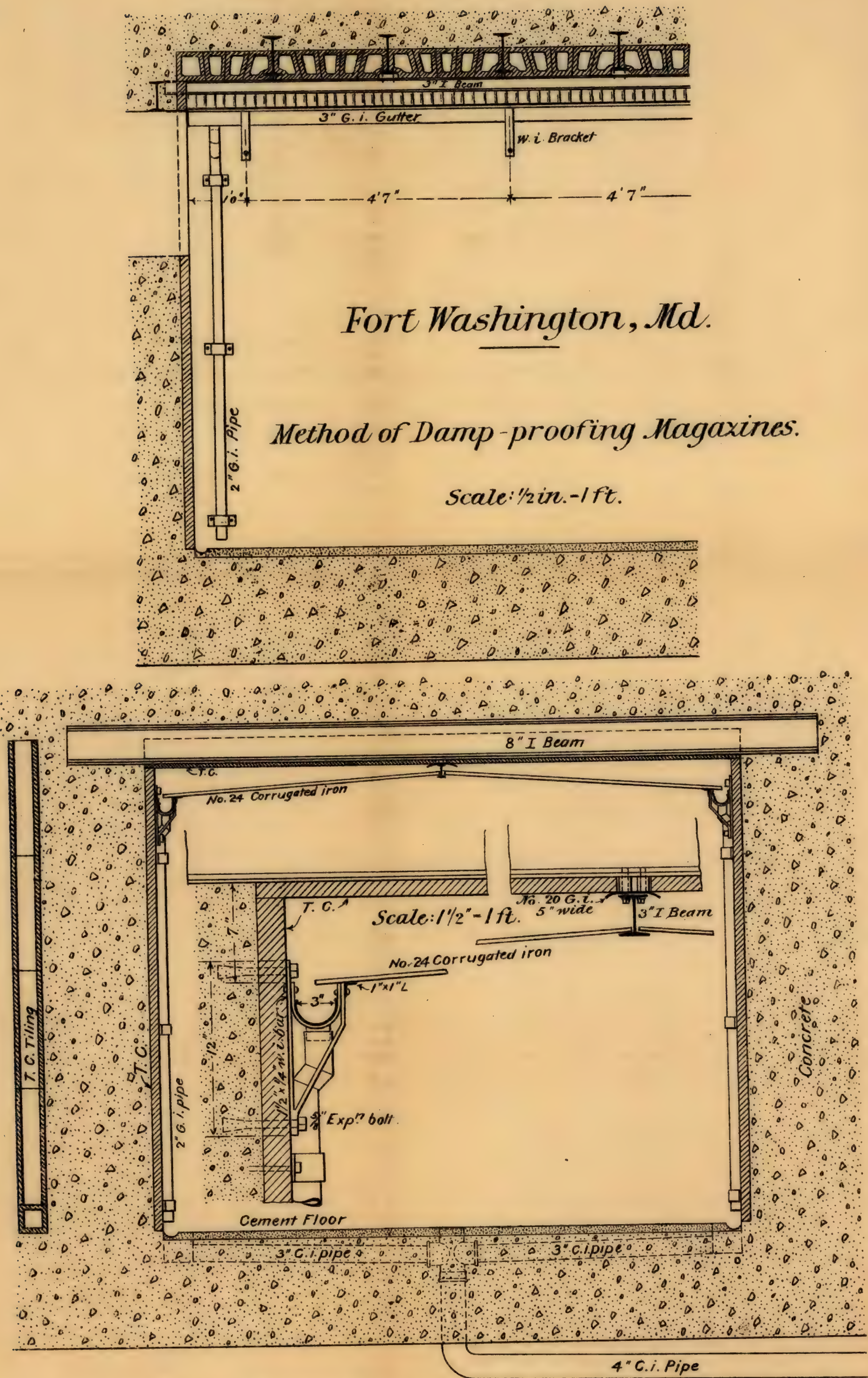
In the matter of paints it is found that red lead is superior to either graphite or a combination of graphite and lead. A priming coat of red lead on iron cleaned with the sand blast has weathered six months without any deterioration.

Regarding "cold-water paints" for battery interiors, the experience of the six months is not any too favorable to them. Unless there is superior ventilation the animal matter, generally casein, used as a vehicle for the calcium salt decomposes along the floor line and in corners, and then gives off offensive odors. Where the walls have the necessary light and ventilation "asbestine" and "indeliblo" make nice, hard, white surfaces which do not rub. For magazines and interior chambers there is no surfacing to compare with whitewash, mixed with tallow, lye, and bluing. It may rub some, but the atmosphere of the room or gallery is sweeter and much more pure. "Sylvester's wash" has been successfully applied to exterior concrete surfaces which had been pointed—not plastered—six months or a year before.

Fort Washington, Md.

Method of Damp-proofing Magazines.

Scale: ½ in.-1 ft.



To accompany Lieut. Col. Allen's Annual Report for 1903.

ANDREW B GRAHAM PHOTO LITHO WASHINGTON D.C.

WATERPROOFING.

The emplacements in this harbor have no condensation with which to contend, excepting in very rare instances in winter, when the iron doors will at times "sweat" on the interior. So the problem of obtaining dry rooms is simplified by having percolation only to provide against.

The problem concerns two types of emplacements—(*a*) those with overhead earth cover and (*b*) those without. Water or moisture may enter from three directions—the roof, the walls, and the floor.

Concerning the first type (*a*), there are several emplacements on the north side of the harbor of this character. The first two were built some years ago, very hastily, under the stress of war conditions. They are of the same style, with about 10 feet of earth cover of yellow clay; and while one has remained absolutely dry, the other has leaked in every room and passage since it was built. It is not known how the back filling was done. It is very probable that the roof surface was not properly finished off and painted. The percolation is entirely through the roof. Nothing has been done to correct the trouble; several estimates have been submitted with the annual "Preservation and repair estimates," but none has been approved.

A later style of emplacement with vertical earth cover is now being built. (See Pl. II, herewith submitted.) The sketch shows plainly the construction. Three-inch book tile is laid flat on a 3-ply felt, tar, and asphalt roof, and the cover is made of fine dry sand from the neighboring hillside. The same construction was adopted at the mortar battery, with the exception that S-shaped Spanish tile was used in place of the book tile and no roofing felt was placed under it. The Spanish tile was laid on a heavy bed of mortar, over the rough concrete roof. In addition, when back filling, the tile was covered with a bed of straw; then coarse shale rock, 6 inches in depth, from the excavation of a near-by battery; after which the sand back fill proceeded. The method has proven very efficient in obtaining a dry battery. Its cost was approximately 23½ cents per square foot, while the estimated cost of the book-tile method is 16 cents per square foot.

Concerning the second type (*b*), those with no vertical earth cover, various experiences have been had and various treatments have been resorted to. The 6-inch rock asphalt roof was removed from one of the earlier (1896) batteries, and 6 inches of good concrete was substituted, then painted. (See Annual Report for 1901, p. 868.) The emplacements have since been dry. At another battery, where the foundations proved insecure and the masonry cracked badly, a tin roof was placed over the roof areas (see Annual Report for 1902, Appendix Z Z, p. 2474), a method which has proven ample to give good dry rooms. The roof of a battery built three years ago was painted with P. & B. paint, several-coat work. It never proved satisfactory; the oil seemed to evaporate, leaving the asphalt constituent to blow away. Moist spots appeared in the ceilings of the passage and of one room. The concrete at this battery was made from coarse broken stone, from which the screenings had been removed. It has since been considered that there was not enough fine material to make good masonry. Rubblestone in considerable quantities was also placed in the roof as well as in the walls; the concrete therefore is not wholly water-tight, but it is believed it will be made so by having an impervious roof covering. The asphalt paint was removed during the past fiscal year and

replaced with boiled linseed oil and sand, as described in the succeeding paragraph.

The roofs of all the later emplacements, as well as the tops of parapet walls, have been given a sidewalk finish, without any joints whatever, regardless of the extent of area. The surface is then given two coats of boiled linseed oil, allowing the cement to absorb all the oil it will take. The third coat consists of oil and Prince's metallic brown, and, while the paint is still wet, screened sand (No. 10 screen), carefully dried, is swept over the surface. The paint dries slowly, and when finally hard the sand has become an intimate part of the roof covering. A year's service, with considerable walking on the roofs at one battery, has proven the treatment to be an excellent one.

Little or no trouble has been experienced from dampness coming through the walls or floors. At one battery, where the side wall of a passage has a thickness of 4 feet and has a southern exposure in elevation, it is believed that water has been driven horizontally through the wall on the line of a cold joint (between two days' concreting) during heavy rainstorms. The wall has been lately treated with two coats of "Sylvester's wash."

The method of obtaining dry rooms under loading platforms has been described under the heading "Walls and roofs."

TRANSPORTING ORDNANCE.

The transportation of ordnance, gun carriages and guns, has been done on this bay by contract by the Quartermaster's Department. The gun material has been taken on barges of from 18 to 24 inches draft. The barges were beached or taken along the side of wharves to discharge the material. The outer point of the harbor, however, presented a different problem. The swell on the ocean beach at all seasons of the year has made it unsafe to attempt landings on that side of the point, while the inner side has only small rocky beaches skirting the shore, with heights of several hundreds of feet to scale before reaching ground that is in any way level. The shore on the inner side is protected somewhat from wave action by the point, but it is not protected from the dead swell, which comes in almost every day of the year. Hence one of the beaches close in to the point, with a break in the cliff line immediately back of it so that the ordnance could be taken up a gulch, was selected for the barge landings. The rocky character of the beach is illustrated by the photograph herewith transmitted.

Much blasting had to be done to remove points of rocks which were submerged at high tide, after which the contractor for the Quartermaster's Department constructed a landing cradle (or "gridiron," as he terms it), to safely beach the barge, and to prevent it from drifting laterally while being unloaded.

The cradle consists of an altar portion, two end cribs for weighing down the altar, and side guides connecting the cribs with the shore. The altar was first built. Its construction is as follows: 6 by 12 inch planks, 8 feet long, were spiked to two 6 by 12 inch sill pieces to form the floor; 12 by 12 inch timbers, 50 feet long, were then built up on this floor, two in height, to form the sides. The structure was then floated into place at low tide, was sunk by filling with rock, after which the deck was nailed on. Upon the two ends were built rock-filled timber cribs, 6 by 6 feet inside dimensions, to the height of about 10 feet. The side guides, acting as shore anchors, joined these cribs and took the thrust of the wave action. The guides were 12 by 12 inches, 60-foot

POINT BONITA.

waling pieces, with 4 by 12 inch plank sides driven into the beach to retain the rock fill.

The structure, as built, was not a success at the start. Beach shingle and loose rock was brought in over the altar by the waves and shoaled the inclosed area considerably. A single tide would level a day's work previously done in attempting to keep it free from accumulations. A portion of the planking and its rock fill was then removed from the westerly guide (as seen in the photograph) so as to permit the wash to escape. No more trouble was then experienced in keeping the area free from shingle.

In taking the 12-inch gun (seen in the photograph loaded on the barge) up the gulch to level ground above, the contractor used the following rigging. Two coils of 5½-inch manila rope were strung through four triple and two single blocks; on the ground above were four capstans operated with four horses, each of the sets of two capstans taking the two ends of one bale of rope strung through one triple block attached to deadman above, and one triple block attached to the forward end of the wood cradle on which the gun rested and one single block attached to the rear end of said cradle. In this manner the strain in the 16 ropes, while working, was the same as if the whole weight were being raised with only 8 ropes, but it had the advantage of double the speed. The slope was about 22½°, the weight 130,000 pounds (gun and cradle), and assuming friction (in tackle and in rollers) to be 30 per cent, the weight actually drawn was 70,000 pounds, or 8,750 pounds per single rope. The length of the slope was 470 feet; the gun was gotten up in about 12 hours' work, with a force of 12 men and 4 horses. The gun cradle was carried on rocker shoes with maple facings; the rollers were 6 inch laurel; the way plank was 4 by 10 inch maple carried on heavy Oregon fir timber, supported by slight trestling over uneven ground where necessary.

IN GENERAL.

All fortification work in this district is done by the United States with hired labor and with hired teams, as it has been found to be most satisfactory. When workmen are trained to do good work, when their interests can be enlisted to do only the best, referring particularly to mechanics, the quality of the work obtained is more apt to be first class than when done by contract.

The average annual rainfall in this district is from 16 to 21 inches. The usual range of temperature, annual, is from 37° to 85°; it is very rare indeed to have freezing weather, and likewise temperatures above 90° in the summer or fall.

B B B 15.

DEFENSES OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON.

[Officer in charge, Maj. W. C. Langfitt, Corps of Engineers.]

General: In connection with construction of two emplacements for 10-inch guns on disappearing carriages, "Defenses, mouth of the Columbia River," I have the honor to state that certain details of construction have been adopted, not shown on type plans, which seem worthy of record. These are shown on accompanying tracings sheets A to D, inclusive, and the following additional descriptions are added:

Sheet A.—Speaking tubes for transmission of messages from telauto-

graph booth to loading platform.—There has been introduced a new feature in connection with the transmission of messages from the booth to the loading platform by means of speaking tubes, placed as shown, that for azimuths terminating at the front of the gun platform and that for elevations just outside the booth. In the booth the speaking tubes are provided with funnel-shaped mouthpieces placed at a convenient height, with reference to the difference chart table under the telautograph, the idea being that the operator may transmit messages to the guns without moving away from the table, one mouthpiece being labeled "elevation" and the other "azimuth." From experience in hydrographic surveying in reading off and recording angles, it is thought that the proposed arrangement of speaking tubes will prove much more satisfactory and be less liable to confusion than if the messages relative to both elevation and azimuth be transmitted through the sliding door. It is believed that open speaking tubes without mouthpieces at the loading and gun platforms will give better service than if mouthpieces were attached. Provision will be made, however, to attach them, should they later be considered desirable. A sliding shutter, with "peephole," is also provided, as shown.

Sheet B.—Rammer, cosmic, and firing wire and primer lockers.—Rammer lockers: These have been located in the right traverse of the emplacements. They are made as small as practicable, but easily accommodate the number of pieces to be cared for, if properly placed. A double swing-up door is provided for each locker, and may be held in open position by hooks, clamps, or other convenient method. It will be noticed that the doorplate passes inside of the angle iron when closed, thus preventing beating in of rain. Having a storage place for the rammers, sponges, etc., at the loading-platform level places them at the most convenient place for use, and prevents soiling the walls in taking them to and from the loading platform.

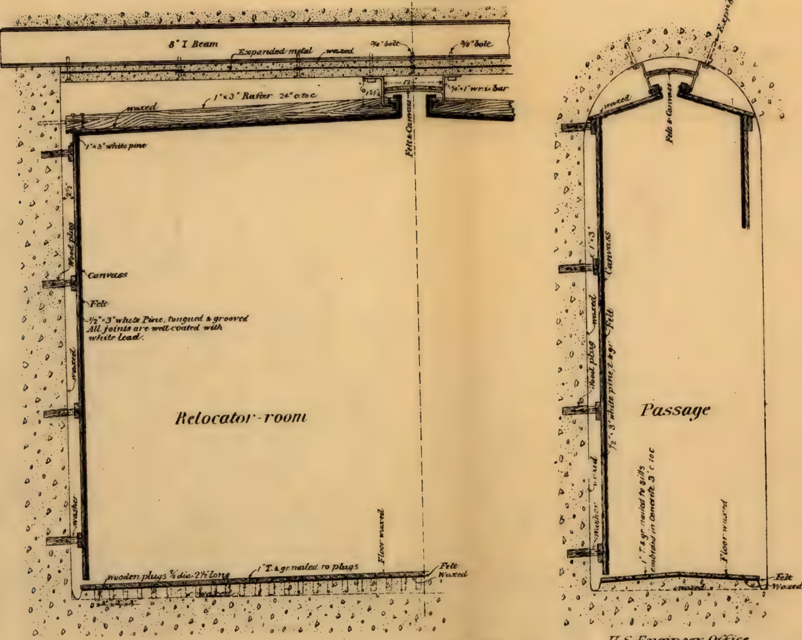
Cosmic locker: Its location is shown with reference to the emplacements under construction, but it may be placed in any other suitable locality. It provides a place directly at the guns, where the principal cleaning materials and tools may be kept for convenient use, without having to carry them up and down stairs every time they are needed, with the usual soiling of the whitewashed walls.

Firing wire and primer locker: This provides a fixed place where the indicated and other supplies needed in connection with firing circuits may be kept and found.

Sheet C—Sliding windows.—This style of window is used throughout the emplacements. Its construction is plainly shown in the drawing. The frame in which is set the wire glass is of T and flat iron. The frame in which it slides or rolls is wood. This method of opening and closing the windows is considered superior to hinged or swinging windows. They were used in a 6-inch battery built two years ago, and seem to give better satisfaction than the old styles.

Sheet D—Tamper for outside walls.—One source of leaks in emplacements which for a long time remained unsolved and which produced very persistent leaks was finally traced to joints caused by separation of layers in the concrete of the exposed perpendicular walls, generally within a few feet of the top surfaces, where the concrete is subject to the greatest variations in temperature. In cutting out these joints or separations to remedy the leaks, it was invariably found that they had an upward slope from the inside to face of wall, permitting the rain beating against or running down the walls to freely enter the

Sketch showing details of damp proofing
Relocator room and passage
Mortar Battery.



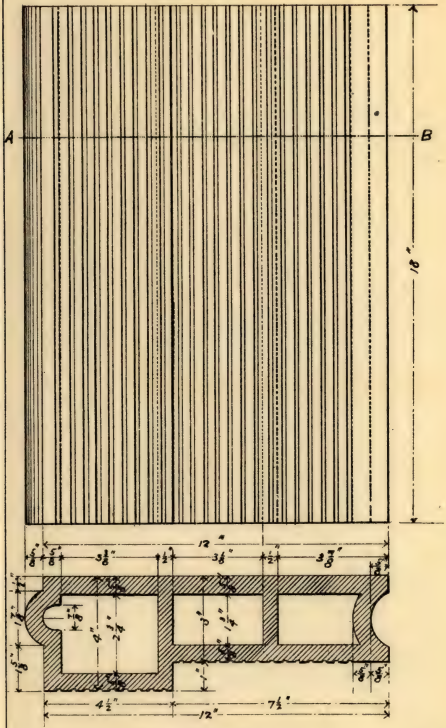
Scale ½ in. = 1 ft.

U.S. Engineer Office
Baltimore, Md. Sept. 15th 1903.

Submitted to the Chief of Engineers, U.S.A. with report of this date by Col. W.A. Jones, Corps of Engineers, U.S.A.

Fig. 2. Details of Tile.

Elevation.



Cross Section A-B

Scale of inches

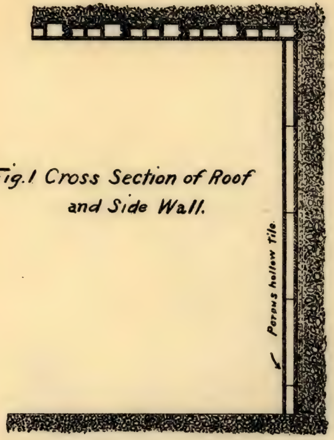
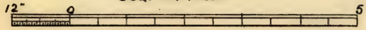


Fig. 1 Cross Section of Roof and Side Wall.

Scale of Feet.



U.S. Engineer Office

Portland Me. Sept 19-1903

To accompany supplement to annual report for fiscal year ending June 30-1903

S. W. Roessler

Major, Corps of Engineers, U.S.A.

ANDREW B. GRAHAM, PHOTO-LITHO. WASHINGTON, D.C.

concrete. These joints or separations are often very small, but they nevertheless cause very annoying leaks. In the drawing are shown the surfaces produced by the different types of tampers. The ordinary type of tampers soon has the square surfaces worn down to a decided rounding, which has been somewhat exaggerated in the drawing, producing the objectionable upward slope, which is further, and to a great extent, aided by the tendency of the tamper to slant away from the form in tamping. The new type of tamper is intended for use against the forms of the outside walls.

Very respectfully, your obedient servant,

W. C. LANGFITT,
Major, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

B B B 16.

NOTES ON PROJECTORS.

BY EDWARD H. SCHULZ, FIRST LIEUTENANT, CORPS OF ENGINEERS, U. S. ARMY.

Other things being equal, the range of illumination of a projector increases as the square root of its power. If the reflected rays must return to an observer near the projector, then the effective range or distance of visibility increases as the fourth root of the power.

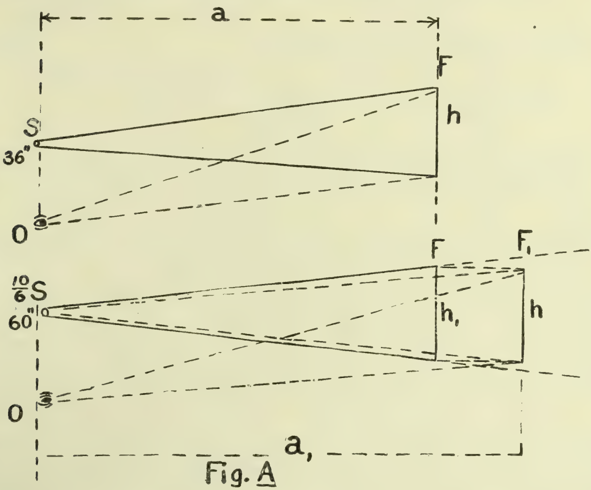


Fig. A

Let us now compare the 36-inch and 60-inch projectors. We will assume for the present that the angle of illumination is the same for each, that their focal distances are proportional to their diameters, and

that their watt efficiencies are the same. Assuming at the arc of the 36-inch 130 amperes at 55 volts = 7,150 watts, and at the arc of the 60-inch 200 amperes at 60 volts = 12,000 watts, we see that their powers will be as 7.15 to 12, or very nearly as 36 to 60; in other words, proportional to their diameters. Let us suppose that the 36-inch projector will illuminate an object F at distance "a" to a brightness h, then the 60-inch will illuminate the same object at same distance to a brightness of $h_1 = \frac{10}{6}h$. As the illumination is inversely proportional to the square of the distance, the 60-inch will illumine the object to an intensity h at a distance a_1, equal to $\sqrt{\frac{10}{6}}a$; in other words, the ranges of equal illumination are as $\sqrt{10}$ is to $\sqrt{6}$ or $\sqrt{60} : \sqrt{36} = 1.29$, and the range has been increased very nearly three-tenths.

Let us now suppose the observer at O, at distance "a" from the object. The visibility or, in other words, the brightness on the retina of an observer at a unit's distance from the object will be ch, c being a constant coefficient representing the reflective capacity of the object F. The visibility at the observer O will then be $\frac{ch}{a^2}$.

Let us assume for the 60-inch the distance xa as one which will give the same visibility $\frac{ch}{a^2}$ to an observer at O. The illumination at xa will then be $\frac{\frac{10}{6}h}{x^2}$ and the visibility at O will be $\frac{c\frac{10}{6}h}{(x^2\ a^2)x^2}$; but this latter must be equal to $\frac{ch}{a^2}$; hence

$$\frac{ch}{a^2} = \frac{c\frac{10}{6}h}{x^4a^2} \text{ or } x^4 = \frac{10}{6},\ x = \sqrt[4]{\frac{10}{6}}, \text{ and } xa = \sqrt{\frac{10}{6}}\,a = 1.14\ a,$$

or, in other words, the effective ranges or distances of equal visibility of different projectors are proportional to the fourth roots of their powers. In this case the effective range is increased about one-seventh.

Going now to the projectors as actually constructed, we find the following (see M and N, Table II): The 36-inch beam has an angle of divergence of 2° 44′, whereas the 60-inch has but 2° 2′, the focal distance in the 60-inch is proportionately less, and the watt efficiency greater, all three of the above conditions thus increasing the intensity of illumination. On the other hand, there is a decrease of actual watts and a slight additional loss due to absorption by the atmosphere.

Going now to Table II, we find that the illumination at 1,000 meters is 54.7 lux for the 36-inch and 161 lux for the 60-inch; the range of the 60-inch for illumination of 54.7 will be $\sqrt{\frac{161}{54.7}}$ times 1,000 meters = 1.71 kilometers, or, deducting for absorption, the range will be about 1,650 meters. To find the effective range or distance of visibility we have the square root of 1.65 = 1.29; in other words, the effective range of the 60-inch as taken from Table II is about one-third greater than the 36-inch, although the diameter is nearly twice and the power

almost half again as great. This same result is shown in Table I, column 13. If it were not for the much smaller angle of illumination, which increases the illumination $\left(\frac{2^\circ\ 44'}{2^\circ\ \ 2'}\right)^2=\left(\frac{164}{122}\right)^2=\left(\frac{4}{3}\right)^2$ approximately or almost twice, we see that the range of illumination and distance of visibility would more nearly equal the values obtained in the

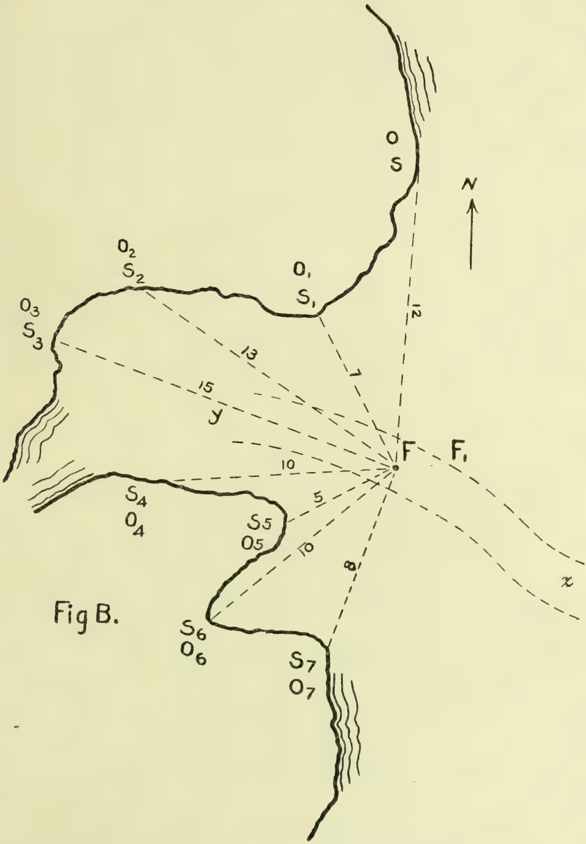


Fig B.

theoretical case above cited, where all conditions were assumed the same, except the powers, which were proportional to the diameters.

From the above we see that mere increase in power or size of projector does very little toward increasing the effective range. It is only when the distances between projector, object and observer are properly related that marked advantages will result.

It is well established that the angle between the projector, object and observer should be as large as possible up to 60°; it is not advisable to go beyond 85°. Any angle over 20° will give excellent results. In Fig. B let y-z represent the channel to the harbor, and let F be the position of a vessel within the range of the shore batteries. Let S, S_1, S_2, etc., and O, O_1, O_2, etc., represent the positions of the projector or observer, the figures 12, 7, 13, etc., representing the relative distances from F.

Considering now the projector S and observer O, and representing its power by A, we see that the illumination of F will be proportional to $\frac{A}{12^2}$, and the impression on the retina of the observer at O_1 may be represented by $\frac{cA}{12^2 \times 7^2}$; in the same manner we find the values of visibility on the other lines as follows:

Line.	Value of visibility.
SFO_2	$=\frac{cA}{12^2 \times 13^2}=\frac{cA}{24336}$
SFO_3	$=\frac{cA}{12^2 \times 15^2}=\frac{cA}{32400}$
S_1FO_2	$=\frac{cA}{7^2 \times 13^2}=\frac{cA}{8281}$
S_1FO_4	$=\frac{cA}{7^2 \times 10^2}=\frac{cA}{4900}$
S_2FO_3	$=\frac{cA}{13^2 \times 15^2}=\frac{cA}{38025}$
S_2FO_4	$=\frac{cA}{13^2 \times 10^2}=\frac{cA}{16900}$
S_2FO_5	$=\frac{cA}{13^2 \times 5^2}=\frac{cA}{4225}$
S_2FO_6	$=\frac{cA}{13^2 \times 10^2}=\frac{cA}{16900}$
S_3FO_4	$=\frac{cA}{15^2 \times 10^2}=\frac{cA}{22500}$
S_3FO_5	$=\frac{cA}{15^2 \times 5^2}=\frac{cA}{5625}$
S_3FO_6	$=\frac{cA}{15^2 \times 10^2}=\frac{cA}{22500}$
S_4FO_5	$=\frac{cA}{10^2 \times 5^2}=\frac{cA}{2500}$
S_4FO_6	$=\frac{cA}{10^2 \times 10^2}=\frac{cA}{10000}$

$$S_4FO_7 = \frac{cA}{10^2 \times 8^2} = \frac{cA}{6400}$$

$$S_5FO_6 = \frac{cA}{5^2 \times 10^2} = \frac{cA}{2500}$$

$$S_5FO_7 = \frac{cA}{5^2 \times 8^2} = \frac{cA}{1600}$$

$$S_6FO_7 = \frac{cA}{10^2 \times 8^2} = \frac{cA}{6400}$$

From the above we see that the most favorable combination is $S_5FO_7 = \frac{cA}{1600}$ and the worst is $S_2FO_3 = \frac{cA}{38025}$. In the latter case the sum of distances is 28, in the former it is 13, yet their visibilities are about as 1 to 24.

In the case of S_5FO_7 the light and observer may be interchangeable, having no effect on the visibility. There are, however, other considerations, the light being retained at S_5 on account of the greater protection available. On the other hand, if placed at O_7 it has a greater range to the south. We thus see that the light and observer should both be advanced as far as possible, and that the product of the squares of the distances to the most probable field should be a minimum.

Taking now the lines S_1FO_2, S_4FO_6, and S_3FO_5, we see that the sum of the distances is in each case 20; the values of visibility are, however—

$$\frac{1}{7^2 \times 13^2}, \frac{1}{10^2 \times 10^2} \text{ and } \frac{1}{15^2 \times 5^2} \text{ or as } \frac{1}{8281} \text{ to } \frac{1}{10000} \text{ to } \frac{1}{5625}.$$

We thus see that S_3FO_5 is decidedly the best line of the three, the visibility being nearly twice as great as on the line S_4FO_6.

Hence we see that for the same sum of distances the most favorable positions are those which will cause the product of the squares of the two distances to the most probable field to be a minimum.

In the case of the line S_4FO_6, in which both legs are equal, if we double the power S to 2S the illumination of F will be doubled also, and likewise the visibility. If, however, we wish to advance F to a position F_1, so that its new visibility with 2S will equal its old at F, with S, we can advance F only to a position $F_1 = \sqrt[4]{2} \times 10 = 11.9$ from S_4, or to a distance of 1.9 from F, about one-fifth of the original distance.

If the legs are unequal and we increase the power, the effective range will also increase, but in absolute distance less than with equal legs whose sum is the same, because as the range increases the legs approach equality.

In the case of unequal legs, advancing one station (shortening one leg) will not advance the point F to the same extent.

In general it may be laid down that the angle between projector, object and observer be from 20° to 60°, and that each distance be as short as possible, so that the product of their squares is a minimum.

The meter candle or normal candle is 0.97 of the English candle; its power is called "pyr" and its illumination at a meter's distance is

called a "lux." Full sunlight is about 80,000 lux and bright moonlight 0.16 lux. Illumination for effective searching should be one-half to 1 lux.

The increased cost of the 60-inch projector is due to the great care required in the construction of the parabolic mirror, as yet not made in this country.

To overcome this difficulty, it might be possible to mount two 36-inch projectors on one platform side by side, adjusting them so that their beams will be parallel or slightly converge toward each other. They could then be moved in elevation or azimuth together.

There are several marked advantages of this arrangement:

1. The cost of the two projectors would be much less than the one 60-inch projector.

2. They could be used singly or together, especially important if the mechanism or arc of one lamp becomes injured.

3. Being placed side by side, less useful light is lost in the vertical direction and more gained horizontally.

Light Projector Table 1.[a]

	1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	D=diameter of mirror.		Normal current (ampères).	Focal distance (inches).	Crater diameter (inches).	Angle of illumination (α).	Ratio of diameter to 36″.	D in inches.	D in inches.	Ratio of brilliancy of crater to 36″.			Yards.[b]	Concentrated beam e (yards).	e for dispersion of (yards).[c]				Yards.[d]	
	Cm.	Inch.				° ′	$\frac{D}{36}$	$\sqrt{D}$	$\sqrt{\frac{D}{36}}$	$\frac{i}{i\,36}$	$\sqrt{\frac{i}{i\,36}}$	$\sqrt[4]{\frac{i}{i\,36}}$	a		10°	20°	30°	45°	Ismid.	Nuremburg.
	35	14	20	7	0.36	2 56	0.389	3.741	0.624	0.68	0.825	0.908	**955**	1,700	1,110	945	855	765	7,780	4,775
	40	16	30	8	.376	2 42	.444	4.000	.666	.76	.872	.934	**1,165**	1,865	1,200	1,010	915	820	8,445	5,220
	45	18	40	8	.40	2 52	.500	4.242	.707	.86	.927	.963	**1,390**	2,035	1,335	1,120	1,020	915	9,275	5,720
	60	24	60	10	.484	2 47	.666	4.899	.8165	.914	.956	.978	**1,900**	2,390	1,555	1,310	1,175	1,065	10,885	6,720
	60	24	70	11.2	.54	2 46	.666	4.899	.8165	.944	.972	.986	1,935	2,410	1,565	1,320	1,190	1,075	11,000	6,775
	75	30	80	12.4	.612	2 50	.833	5.477	.9128	.966	.983	.9915	2,445	2,700	1,765	1,490	1,330	1,210	12,285	7,620
	90	36	100	15.2	.72	2 43	1.000	6.000	1.000	1.000	1.000	1.000	3,000	3,000	1,945	1,635	1,475	1,330	13,665	8,445
M	90	36	120	16.8	.80	2 44	1.000	6.000	1.000	1.018	1.010	1.005	3,000	3.000	1,945	1,635	1,475	1,330	13,665	8,445
	110	44	150	20.8	.92	2 33	1.222	6.633	1.105	1.066	1.030	1.015	3,665	3,335	2,120	1,790	1,600	1,455	15,110	9,330
N	150	60	150	26.0	.92	2 2	1.666	7.746	1.291	1.066	1.030	1.015	5,000	3,835	2,310	1,955	1,755	1,585	17,775	10,940

[a] Translated from Light Projectors for Army and Navy, by F. Nerz.

[b] Distance of illumination a, when its value is 3,000 yards for a distance of sight of 3,000 yards; the figures in this column give the distance between projector and object, so that the latter may be seen by an observer 3,000 yards distant from object.

[c] Effective range in yards, in which it may be observed whether shots fall too high or too low, in which working forces may be distinctly seen in intrenchments or in which torpedo boats may be discovered.

[d] Effective range in yards, in which large light-colored buildings, churches, barracks, etc., may be seen—determined from tests at Ismid and Nuremburg.

Light Projector Table II. [a]

	Diameter of mirror.		Current (ampères).	Pressure (volts).	Watts.	Normal candlepower pyr (per watt).	Intensity of rays falling on mirror (pyr).		Mean intensity of reflected rays (pyr).	Crater diameter (inches).	Mirror coefficient.	Intensity of the reflected beam at a distance, absorption of the atmosphere not considered (pyr).	Focal distance (inches).	Divergence of beam.	Diameter of field in yards at 1,000 yards.	Illumination in meter candles, "Lux" with an absorption of 10.4 per cent per kilometer=9.36 per cent per 1,000 yards.	
	Cm.	Inch.					Max.	Mean.						° ′		At 1,000 meters.	At 2,000 meters.
	40	16	20	43.5	870	4	3,480	2,780	2,500	0.372	1,854	4,635,000	7.2	2 58	51	4.57	0.93
	40	16	25	44	1,100	4.6	5,000	4,000	3,600	.376	1,811	6,490,000	7.2	2 59	52	5.8	1.3
	40	16	30	44	1,320	4.8	6,300	5,000	4,500	.38	1,773	8,000,000	8	2 43	47	7.17	1.6
	45	18	20	43.5	870	4	3,480	2,780	2,500	.372	2,341	5,850,000	8	2 40	46	5.24	1.18
	45	18	30	44	1,320	4.8	6,300	5,000	4,500	.38	2,244	10,600,000	8	2 43	48	9.5	2.125
	45	18	40	45	1,800	5.14	9,250	7,400	6,660	.40	2,025	13,500,000	8	2 52	50	12.5	2.7
	60	24	40	45	1,800	5.14	9,250	7,400	6,660	.40	3,600	24,900,000	10	2 18	40	22.4	5
	60	24	50	46	2,300	5.35	12,300	9,800	8,820	.436	3,030	26,700,000	10	2 30	44	23.9	5.35
	60	24	60	47	2,820	5.55	15,500	12,400	11,150	.484	2,459	27,200,000	10	2 47	48	24.3	5.45
	75	30	60	47	2,820	5.55	15,500	12,400	11,150	.484	3,840	42,300,000	12.4	2 16	39	37.8	8.5
	75	30	75	49	3,675	5.8	21,200	17,000	15,300	.572	2.744	42,300,000	12.4	2 38	46	37.8	8.5
	75	30	90	51.5	4,680	6	28,100	22,500	20,500	.668	2,020	42,300,000	12.4	3 6	54	37.8	8.5
	90	36	60	47	2,820	5.55	15,500	12,400	11,150	.484	5,532	61,000,000	12.4	2 16	39	54.7	12.25
	90	36	75	49	3,675	5.8	21,200	17,000	15,400	.572	3,950	61,000,000	15.2	2 8	38	54.7	12.25
	90	36	90	51.5	4,680	6	28,100	22,500	20,500	.668	2,900	61,000,000	15.2	2 32	44	54.7	12.25
	90	36	100	53	5,300	6.05	32,000	25,700	23,130	.70	2,640	61,000,000	15.2	2 43	47	54.7	12.25
M......	90	36	125	55.5	6,660	6.23	41,500	33,200	29,880	.80	2,030	61,000,000	16.8	2 44	48	54.7	12.25
	90	36	150	59	8,900	6.45	57,000	45,600	41,040	.92	1,530	61,000,000	16.8	3 8	55	54.7	12.25
	110	44	150	60	9,000	6.5	58,000	46,400	41,750	.92	2,287	96,000,000	20.8	2 32	44	86	19.25
N......	150	60	150	60	9,000	6.5	58,000	46,400	41,750	.92	4,300	180,000,000	26	2 2	36	161	32.25

[a] Translated from Light Projectors for Army and Navy, by F. Nerz.

RIVER AND HARBOR WORKS.

B B B 17.

REPORT ON EXPERIMENTS FOR DESTRUCTION OF THE WATER HYACINTH IN THE WATERS OF FLORIDA.

[Officer in charge, Capt. Francis R. Shunk, Corps of Engineers.]

UNITED STATES ENGINEER OFFICE,
Jacksonville, Fla., September 11, 1903.

GENERAL: In compliance with Department indorsement dated August 22, 1903, I have the honor to submit the following report on the use of the Harvesta chemical compound for destroying the water hyacinth and the experiments which led to its adoption.

Experiments with steam, petroleum, and various chemicals were first undertaken in 1898, after experience had shown that mechanical methods of killing the plant were so expensive as to be impracticable. These experiments were made at Palatka, Fla., and were, briefly, as follows:

(1) A tract of hyacinths was sprayed with a 50 per cent solution of commercial hydrochloric acid. The tops of the plants died in an hour, but the bulbs and roots showed no change and after thirty days had put out new growth.

(2) Undiluted commercial hydrochloric acid was used. The tops were killed at once, but the bulbs and roots were uninjured, as in the first experiment.

(3) A selected plant was exposed to a jet of steam and hot water at 70 pounds pressure. While the top was killed the bulb seemed to be uninjured and after a time put out new growth.

(4) A tract was treated with a 50 per cent solution of commercial sulphuric acid. Results as in experiment No 1.

(5) Undiluted commercial sulphuric acid was used. The results were entirely similar to those of experiment No. 2.

(6) Crude carbolic acid was used in solution. This was no more successful than the hydrochloric and sulphuric acids.

(7) A tract of plants was sprayed with petroleum. They were entirely uninjured. Subsequently an attempt was made to burn the plants which had been so sprayed. This was unsuccessful.

Negative results only were obtained from this series of experiments.

The next substance tried was common salt. It had been observed that the hyacinths which drifted down the river died after reaching salt water. Solutions of salt of various strengths were applied, and it was found that the plants were killed by a saturated solution. The solution, however, was too heavy to be used as a spraying mixture. It was improved by the addition of quicklime, which caused it to spray readily and also appeared to increase its destructive effect. Enough quicklime was added to make a good spraying mixture; the proportion is not recorded.

This method was successful so far as killing the plant was concerned. Its cost, however, was great, being about 2 cents per square yard, \$96.80 per acre, or \$61,952 per square mile. This is probably a low estimate, no allowance having been made for interest and depreciation of plant or for contingent expenses. As there were many square miles of the hyacinths, the cost of this method was deemed prohibitive.

As sea water is far from being a saturated solution, and the plants

certainly died in sea water, further inquiry was made into the probable cause of their death. Although no certain conclusion was reached, there is some reason to believe that those substances in solution or suspension upon which the plant feeds are precipitated in sea water; the plant then dies of starvation. In order to produce this effect in a river or lake enough of the solid ingredients of sea water would probably have to be added to make a solution approaching sea water in strength. This is out of the question, except in the smallest land-locked pools.

Matters were in this state, no satisfactory method having been found, when the Harvesta chemical compound was brought to the notice of this office. It had been used by private parties in Louisiana and was said to have been successful. The Harvesta Company furnished a quantity of the compound, and experiments were made at Bridgeport, Fla., in August, 1900. At this place there was an inlet filled with hyacinths, closely packed together and not likely to drift away. Tracts of 12 square yards were marked off and sprayed with the liquid. There was no variation in the strength of the solution or mixture, but different quantities were applied to the different tracts—to one, half a gallon; to another, 1 gallon, etc. The plants were carefully observed for several weeks.

These experiments showed that the compound was certainly and quickly fatal to the hyacinths. They began to wither at once; the packs in a few days contracted and broke up, and in two weeks the whole mass was well advanced in decay.

It was also found that the best results were obtained with 1 gallon of the liquid to 12 square yards. With less than this amount some of the plants were not killed and had to be sprayed again. More than this quantity was useless.

Assuming the above proportion, 1 gallon to 12 square yards, the cost was estimated at about one-third of a cent per square yard, $16.13 per acre, or $10,325.33 per square mile. This is one-sixth the cost of the salt treatment and, it is estimated, about one-tenth that of any mechanical process so far tried. These results were so favorable that the compound was recommended for adoption.

The Harvesta chemical compound is a patented article. The active ingredient is arsenic acid. The patent covers a wide variety of combinations, and the exact composition of the compound as used is unknown. It is believed to be rather a mechanical mixture than a true compound. In physical form it is a powder resembling common salt. It is not by itself entirely soluble, and must be digested with other substances in order to produce a liquid suitable for spraying. Two methods of preparation have been used on this work.

First method.—The mixture was made in two tanks, each holding 5,000 gallons. In each tank were placed 233 pounds of the dry compound and 233 pounds of saltpeter and enough water to fill the tanks. Steam at 70 pounds pressure was then introduced by a pipe, the liquid brought to a boil and kept so for about five hours. As a result of this treatment the compound was largely dissolved, and such fine particles as were undissolved remained in suspension.

Second method.—Bicarbonate of soda is substituted for saltpeter. The soda and the compound are believed to enter into true chemical combination; at any rate, the resulting liquid is a true solution. The long time and great dilution necessary in the first method to bring the

undissolved particles into suspension may therefore be avoided. The mixing is done in a tank holding 200 gallons. One hundred and twenty-five gallons of water are put into the tank, and 466 pounds of bicarbonate of soda are added. Steam is introduced in order to facilitate solution. Four hundred and sixty-six pounds of compound are then added, a bucketful at a time. There is considerable effervescence and care must be taken to prevent boiling over. The resulting liquid measures 150 gallons. After complete solution, which requires about forty minutes, 50 gallons of water are added to facilitate pumping. The liquid is then pumped into the spraying tanks and mixed with 9,800 gallons of water.

The second method requires less time, is more economical of steam, and the resulting liquid appears to be more rapid in its action. The first method is no longer used.

For spraying purposes a small steamer, 7 feet draft and 67 feet long, is fitted up with two mixing tanks, capacity 200 gallons each; three spraying tanks, aggregate capacity 10,000 gallons, and a duplex Knowles pump, capacity 80 gallons per minute. The liquid is pumped into two rubber hose pipes, with spraying nozzles directed by hand. The total cost of the plant was $6,345.

Actual work of spraying began on November 10, 1902, but owing to various interruptions there were only eighty working days during the fiscal year ending June 30, 1903. In all, 242,503 gallons of the liquid were used, and about 2,910,000 square yards of hyacinths were sprayed.

The arrangement made with the Harvesta Company is as follows: The company is to furnish the compound and all hose, spray pipes, heads, and nozzles; also a competent man to direct the mixing. The United States is to furnish boat, tanks, pumps, steam, and water, and subsistence and quarters for the company's employee. The price paid is 3 cents per gallon of the mixture prepared for spraying.

The cost of spraying during the past fiscal year was greater than it will be in future, as the expenses of the boat continued during interruptions. The probable cost in future may be estimated as follows. The records show that the average day's work was 36,375 square yards. Assuming 240 working days in a year, this gives a yearly total of 8,739,000 square yards:

8,730,000 square yards, at $0.0025	$21,825
Interest and depreciation of plant, at 16 per cent	1,015
Pay roll and office expenses, $450 per month	5,400
Subsistence, at $150 per month	1,800
Fuel, at $50 per month	600
Miscellaneous expenses	600
Total	31,240

$31,240 ÷ 8,730,000 = $0.003578 per square yard = $35.78 per 10,000 square yards = $3.98 per square of 100 feet = $0.00428 per square meter.

The expectations based upon experiment have been fully realized in practice. So far as present knowledge goes, the Harvesta compound affords the cheapest, quickest, and best means of destroying the hyacinth. Indeed, it is the only method which is at all practicable.

The benefit to navigation has been great, but no progress has been made toward exterminating the hyacinth. The plant has obtained such a foothold and propagates so rapidly that its extirpation would involve an immense outlay and a great number of boats working

simultaneously at different points. Even then, some of the vast swamps where the hyacinth abounds are so inaccessible that total extirpation is probably out of the question. However, a stream might easily be kept free of hyacinths if work were begun as soon as the plant made its appearance.

It remains to consider the effect of the compound upon animal life. Since arsenic is a chief ingredient, it was feared that spraying might destroy fish, and also that the sprayed plants might be fatal to cattle.

No dead fish have been observed after our operations, and as they abound in the St. Johns River and its tributaries, it may be assumed that such poison as reaches the water is sufficiently diluted to be harmless.

It is otherwise as regards cattle. The water hyacinth makes excellent fodder, and is much eaten by cattle, especially in winter when little else is available. It was hoped that the sprayed plants would have a disagreeable taste, so that the cattle would avoid them. They probably do so when other food is available, but when it is a choice between sprayed hyacinths and nothing they will eat the hyacinths. Many deaths during the past winter were attributed to this cause. The cases reported were carefully investigated, and it appeared that while in many instances the deaths were probably due to something else, there were a number of cases in which the sprayed plants were strongly indicated as the cause of sickness. An experiment was therefore made at Palatka in May, 1903. A young cow was provided by the Harvesta Company, and her diet restricted to sprayed hyacinths. She became sick, with substantially the same symptoms as had been reported in other cases, but subsequently recovered. It was concluded that the compound was certainly injurious to cattle. What the injurious ingredient might be was not, however, equally clear. The symptoms did not appear to be those of arsenical poisoning. The kidneys appeared to be involved, and there was some reason to suppose that the saltpeter used in the mixture might be to blame. It was found further that the saltpeter was the ordinary commercial article, and contained a great deal of common salt as an impurity. This would perhaps explain why the cattle ate the sprayed plants. In order to prevent the cattle from eating the plants a little crude petroleum was added to the spraying mixture. This was not successful. Its odor disappeared in a short time, and its only effect was to diminish the action of the compound.

The use of saltpeter has now been discontinued, and bicarbonate of soda is used in its place. It is hoped that the new mixture will be more distasteful to stock, and also that it may not be injurious. No complaints have been received since the change was made, but they are scarcely to be expected at this time of the year. Authority has been obtained to make further experiments with cattle, but this has not yet been done.

It may be added that the compound appears to be fatal to all vegetable life. Brush and trees along the banks, which are accidentally sprayed, always die in a short time.

Very respectfully, your obedient servant,

Francis R. Shunk,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

B B B 18.

TECHNICAL FEATURES CONCERNING IMPROVEMENT OF MISSOURI RIVER.

[Officer in charge, Capt. H. M. Chittenden, Corps of Engineers.]

Character of improvement works.—In a work like that on the Missouri River, a stream sui generis in the strictest sense of the words, methods of improvement must necessarily be the outgrowth of experience. It is no criticism upon the engineer that methods which seemed a priori certain of success have proved by experience to be failures, and in passing judgment upon the relative value of different methods this fact should be kept in mind.

* * * * * * *

From the nature of the two classes of work revetment is more permanent than dike work. The latter, being largely of wood, partly beneath the water and partly above, must inevitably fall by natural decay in a comparatively short time. Revetment work has no perishable material above water, and is therefore exempt from the processes of decay. Dike work is exposed to the direct onslaught of the river, with its ice and drift and rapid current. The revetment rarely, if ever, receives the attack directly, but at such an oblique angle that it glances off with comparatively little impression. Dike works are avowedly for the purpose of changing the flow of the river; their influence is far-reaching; the current may be thrown against other banks, causing new destruction and giving rise to just complaint. The revetment never has this effect, but, on the other hand, tends to hold the river in its existing channel.

Below are given condensed specifications for the construction of both revetment and dike work as practiced on the Missouri River.

Standard permeable dikes.—Permeable dikes are employed where it is desired to contract the river or to force it to any desired position, or to fair out the shore line, advantage being taken of the fact that in high water the river carries in suspension a large quantity of sediment which it deposits at points where the current is checked. These dikes consist essentially of, first, a system of piling driven in rows a short distance apart and braced to resist the action of the water or of ice and drift; second, a woven willow foot mattress to prevent scour, and, third, screening extending from the top grade line of the dike to the bottom of the river, to cut off a portion of the flow of water through the dike, thus causing the current to slow up and deposit a portion of the sediment carried in suspension. The dikes are run out level with the top of the bank, or 2 feet above standard high water, to near the standard high-water contour of the proposed rectified shore and from there sloped down to as near 2 feet above standard low water as the stage of river at the time permits.

When located on the bar side of the river, or the convexed side of bends, the exposure is generally or at least frequently such that the dike is made of increasing strength from the bank out; i. e., commencing at the bank with 1-row work and changing successively to 2-row, 3-row, and 4-row work as the exposure increases with distance.

When located on the concave side of bends the dikes, on account of the exposure, are seldom of lighter construction—fewer rows of piling—at their bank ends than at their stream or outer ends, and in some instances the heaviest construction is near the bank. This is found necessary wherever the thalweg lies close in to the bank and pile penetrations are limited by excessive depth of water, impenetrable bottom, or other cause. The lower dikes of a group are made of lighter construction than the one farthest upstream, excepting that portion of each which projects beyond the influence of the dike next above it.

The construction of the 3-row dike, which is the type in most general use on the river, is shown on the accompanying drawings.

The piles are driven in rows 10 feet apart from center to center, being about 10 feet apart in the rows. Additional piles are driven at the outer end, as shown. The axis of the dike is perpendicular to or inclined to the bank, as local conditions may require. Yellow pine, oak, and cottonwood piles, not less than 14 inches or more than 19 inches in diameter at the butt and not less than 8½ inches in diameter at the point, are used, and they are driven to a penetration of 25 feet.

The foot mattress is woven from the shore to the outer end of the dike, either before the piles are driven or immediately afterwards, before the bracing is put on. The mattress for a 3-row dike is 60 feet in width, extending 25 feet above the dike and 15 feet below, and is woven and strengthened with wire strands, as described in the construction of revetment. At the shore end it is extended upstream 20 feet and at the outer end it is widened to 95 feet. When the dike piles are driven before the mattress is woven it is necessary to use, in addition to the barge above the dike, a small barge below and small punts between the rows of piling. Anchor piles are driven at intervals about 60 to 80 feet above the upper edge of the mattress, and cables from these hold the mattress in position during construction. After the mattress is completed it is loaded with rock to an average thickness of 3 inches and sunk to the bottom, the upper 10 or 15 feet being more heavily loaded than the remainder, to prevent the rolling of the upper edge by the force of the current.

The following system of bracing is used: Waling pieces parallel to the axis of the dike and nearly parallel to the water surface are bolted near the top of the piles in each row and near the water surface of the upper and middle rows. Direct braces perpendicular to the axis of the dike and nearly parallel to the water surface are bolted near the tops of the piles of each bent and also near the water surface, the upper ends being placed for protection immediately against the waling pieces. Two diagonal braces are fastened directly under the upper wales on each alternate pile of the upper row, extending diagonally to the lower row and being fastened to the piles in the lower row near the water surface. The upper end of one of each pair of diagonals is extended so as to protect the end of the other. Extra bracing is put on at the outer end of the dike. The sizes of the pieces of bracing used are shown on the drawing. Bolts three-fourths of an inch in diameter are used for bolting the bracing to the piles.

After the dike is braced the screening poles are put on, the lower ends being trimmed to a point and pushed well through the foot mattress and the upper ends being nailed to the upper and lower waling pieces of the middle row of piles. The screening poles are from 1¼ to

Fig. 2. Details of Tile

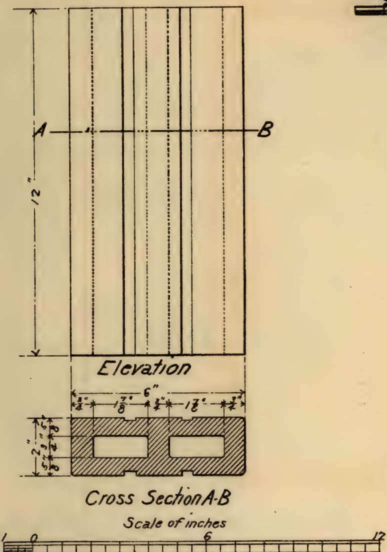
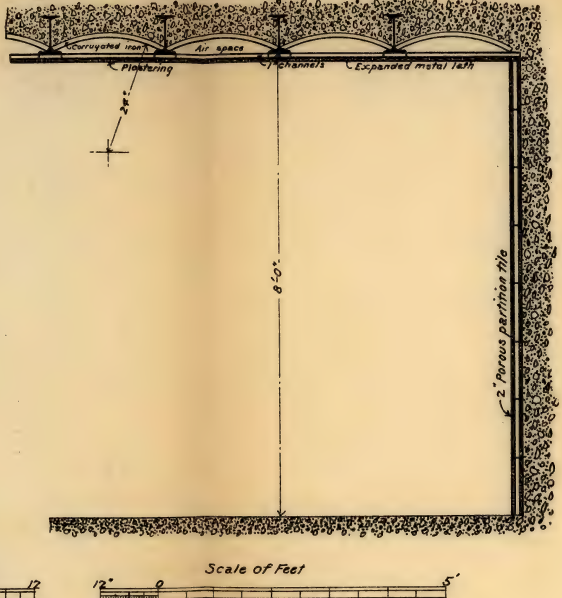


Fig. 1 Cross Section of Roof and Side Wall



12 INCH BATTERY

PORTLAND HARBOR, ME.

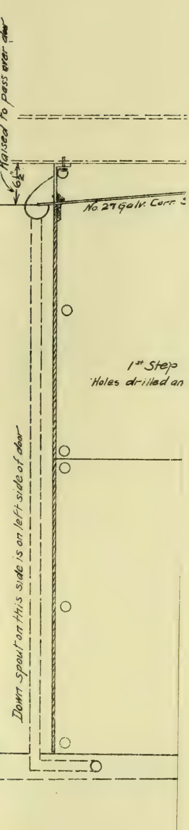
U.S. Engineer Office
Portland Me. Sept. 19. 1903

To accompany supplement to annual report for fiscal year ending June 30 1903

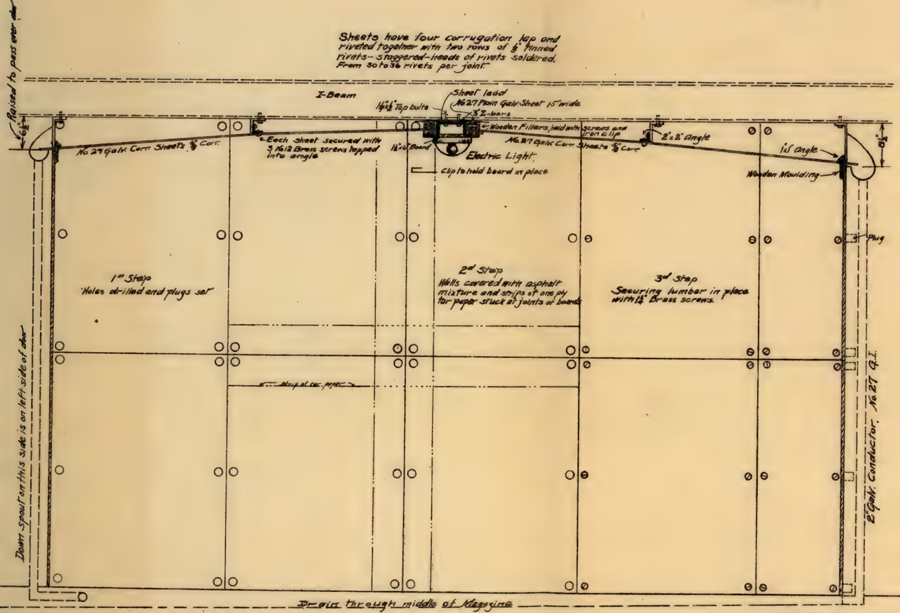
S. W. Roessler
Major, Corps of Engineers, U.S.A.

ANDREW B. GRAHAM, PHOTO-LITHO WASHINGTON, D.C.

Drawn by Walter M. Smith
Jr. Engr.



ANDREW B GRAHAM, PHOTO LITHO WASHING



Eng 58 1

Damp Proofing

Powder Magazine No. 3

10-inch Battery

with

Magnesia Lumber and Metal Ceiling.

Scale ½"=1'

Fort Moultrie S.C.

U. S. Engineer Office,
Charleston, S. C., August 19, 1903.

Accompanying my report of this date.

G. P. Howell
Captain, Corps of Engineers

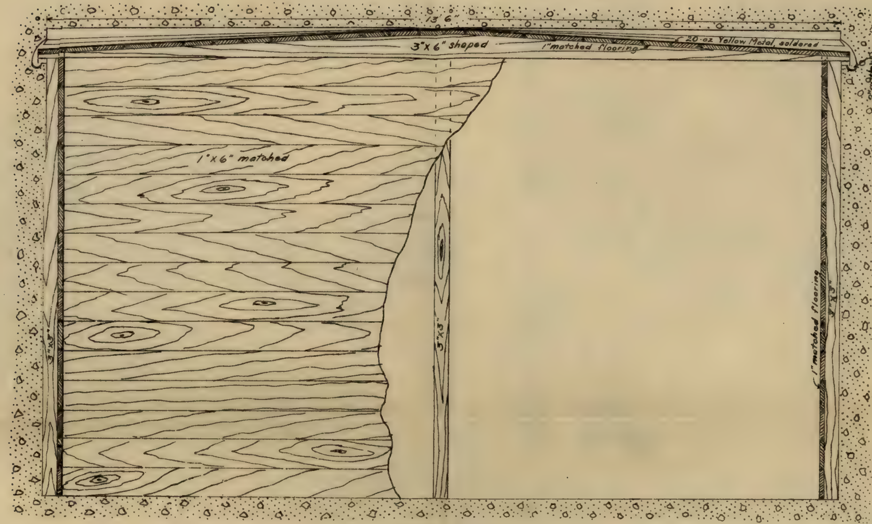
ANDREW B GRAHAM, PHOTO LITHO. WASHINGTON D C

L SECTION.

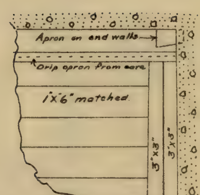
PLAN
for
LINING MAGAZINE No. 4,
BATTERY JASPER,
S.C.

Scale: ½" = 1'.

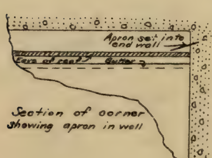
1903.



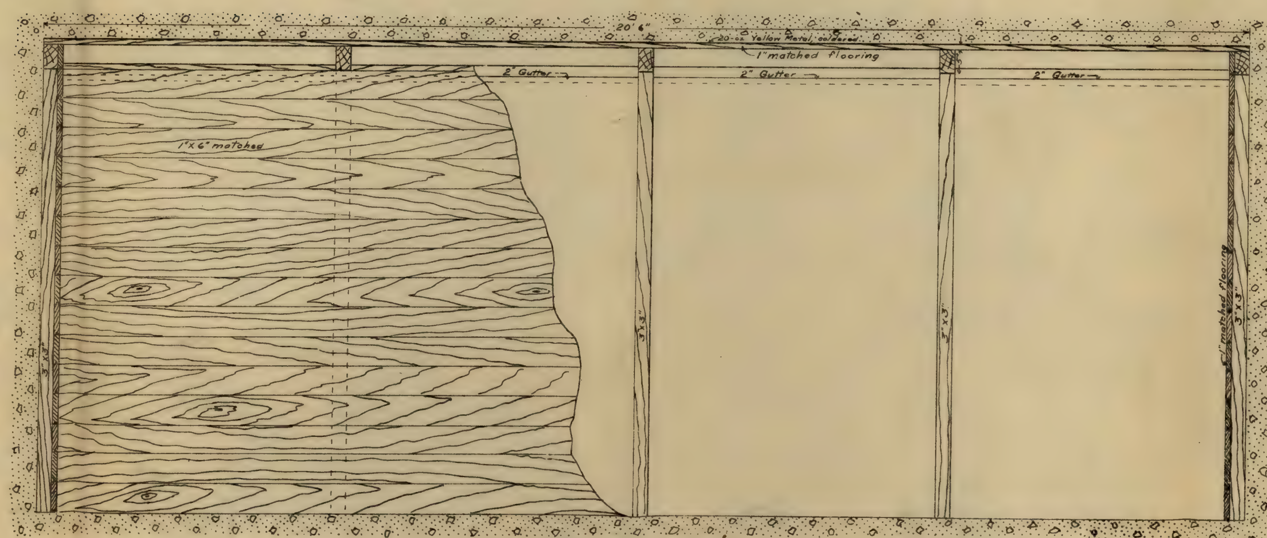
CROSS SECTION



Side elevation of corner showing apron on end wall



Section of corner showing apron in wall



LONGITUDINAL SECTION.

U.S. Engineer Office,
Charleston, S.C., August 18, 1903.

Accompanying my report of this date.

G. P. Howell

Captain, Corps of Engineers.

2½ inches in diameter at the top and from 2 to 4 inches in diameter at the butts. A pile supported at one end by the middle pile of the inner bent and at the other by a pile head planted at the top of the graded bank is placed, in order that the screening may be continued to the top of the bank. The screening poles are spaced so that about one-half of the section is cut off at the inner end of the dike and about one-quarter at the outer end, the spacing varying as nearly uniformly as possible between these points. At the shore end of the dikes the bank is graded to a slope of 1 to 2 and revetted to the top of the bank, or 2 feet above standard high water.

In cases where circumstances prevent the procuring or use of poles for screen work wire netting is placed in front of the upper line of piling. Area of mesh, about 24 square inches.

After the outline of the accretions becomes defined, or within a period of three years after the completion of the dike, that portion of the dike beyond the accretions is reenforced by filling in with mattress and stone, to form a submerged spur extending on an approximately uniform slope about 40 feet beyond the dike head.

Filling blocks.—All double-direct braces are provided with filling blocks 30 inches long, fitted close up to the pile at each end of the brace, and held in place by two three-fourths-inch screw bolts. The object of this device is to relieve or reenforce the bolts which fasten the brace to the pile.

Strand ties.—The use of wire strand ties to transmit stress from the top of dike in the lower row to the base of the structure at the upper row adds a measure of stability previously obtained by the more expensive method of double-system bracing or additional row of piles. The ties are of several parts of three-eighths-inch strand, or one or more parts of three-fourths-inch strand as indicated by the stress. They are usually attached to the upper pile before driving, at a point that when driven will be on or near bottom, a round turn being taken on the pile and the bight of it fastened there by a staple; if a single-part tie, the short end is clipped on the other close up to the pile, and the tie, whether of one more parts, is then lashed up alongside of the pile until the mattress shall have been sunk in place, when it is made fast at the top of the pile in the lower row.

COST OF DIKE CONSTRUCTION.

Consolidated bill of cost of constructing 550 linear feet of three-row dike on the Omaha reach, season of 1900.

Classification.	Quantity.	Cost per item.	Cost of material.	Labor, fuel, etc., in constructing.	Percentage of total cost.	Total cost.
Piling (pine piles) ....linear feet..	9,006	$0.22	$1,978.43	$388.62	39	$2,367.05
Bracing (pine lumber), bolts, spikes, etc., feet B. M.	14,989	a 15.24	228.50 165.59	281.57	11	675.66
Mattress weaving and screening:						
Brush and poles..............cords..	247.6	1.27	314.42	407.47	17	999.86
Strand ($\frac{3}{8}$), galvanized .....pounds..	4,180	.665	277.97			
Ballasting (stone) ....tons..	391.2	1.12+	439.47	95.00	9	534.47
Grading and paving bank					1	48.71
Inspecting and handling materials					8	502.50
Steamboat service (towing)					10	584.59
Incidentals					5	293.32
Total cost of 550 linear feet of dike, at $10.92 per foot					100	6,006.16

a Per 1,000.

Revetment is used to protect the river bank from erosion. It consists essentially of paving with rock the portion of the bank above low water and protecting the portion of the bank below low water from erosion and undermining by means of a woven willow mattress weighted with rock. The mattress is extended beyond the foot of the bank a distance, depending on the depth of the water, sufficient for protection against any scouring action of the river, the woven mattress being elastic and adjusting itself readily to changes in the bottom.

Standard revetment as constructed on the Missouri River is shown in detail on the accompanying drawing.

In protecting a bank by revetment the work is taken up in the following order: First, bank grading; second, weaving mattress; third, sinking and ballasting mattress; fourth, paving and spawling upper bank.

Bank grading.—The upper bank is graded between the water surface existing at the time and the 2-foot contour above standard high water, to a slope varying from 1 on 2 to 1 on 3½ or flatter, in special cases, depending upon the character of the material composing the bank and the attack to which it is exposed. The grading is best done by a hydraulic jet. Care is taken not only that the graded slope shall be smooth and free from ruts and gullies, but that no part of it above water shall be formed of tailings. The settlement of tailings leaves a shoulder on the bank which, unnoticed or not properly treated, invites destruction of the upper bank work. Partly on this account, the best revetment can be constructed when the stage of river is lowest.

The hydraulic grading outfit in its latest development consists of a grading boat having a hull 20 by 80 feet on which there is a compound condensing steam pump of the packed-plunger pattern having a capacity of about 600 gallons a minute at a piston speed of 100 feet per minute; a steam capstan at the pump end of the boat for use in moving the boat and for light snag pulling or grubbing; a hand capstan at the other end of the boat, and a boiler for steam supply. The pump and boiler are inclosed with a cabin, which provides sleeping quarters for the crew. A mast at each corner of the pump end of the cabin is used to operate a boom in which the discharge hose is carried ashore on either bank.

The pump gets its water supply through a screened suction pipe in a screened well within the hull. The discharge is carried in a 6-inch iron pipe from the pump to both gunwales, at the foot of the masts, for use on either bank of the river. The one not in use is capped. From the boat to the play pipe ashore the water is conducted in 4-inch rubber hose, 75 feet of it being required under ordinary conditions.

The play pipe at the shore end of the hose is of copper, 4 feet in length, and tapers from 4 inches in diameter at the hose to 2 inches at the nozzle end. It is operated by a wooden lever about 8 feet long, to which it is fitted and strapped. The lever is held against recoil and given full movement in all directions by means of a gimbal which sets at an elevation of 16 to 20 inches above grade in a 2-inch gas pipe that is driven firmly into the earth.

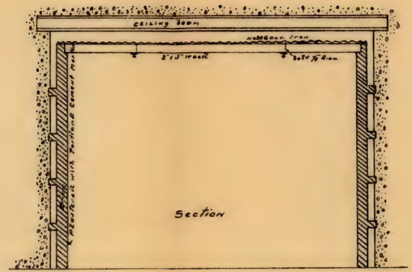
The jet is played upon the bank at close range. The form of nozzle tip that gives the best results, the most compact, solid jet, is cylindrical for 2½ diameter back from the orifice, and thence to the play pipe connection conical. The cylindrical surface of the tip should be kept highly polished. With the pump working at full capacity and an average bank, a jet 1¼ inches in diameter gives the best results.

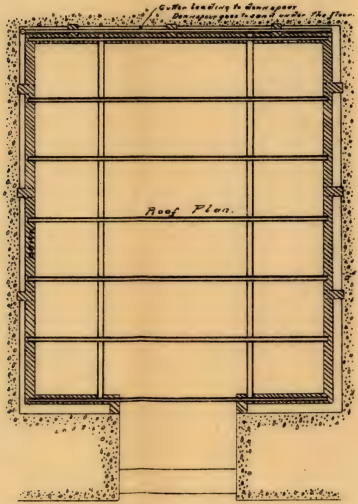
ketch showing plan used for
Damp-proofing powder magazine.

Scale ¼ in. = 1 ft.

U.S. Engineer Office,
Jacksonville, Fla., September 15th 1903.
To accompany Letter of date.
Francis R. Shunk
Captain, Corps of Engineers U.S.A.

PLATE 1





Sketch showing plan used for Damp-proofing powder magazine

Scale ¼ in. = 1 ft.

U. S. Engineer Office,
Jacksonville, Fla., September 15th 1903.
To accompany Letter of date.

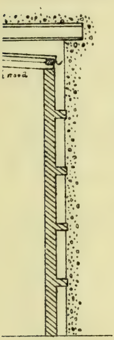
Francis R Shunk
Captain, Corps of Engineers U. S. A.

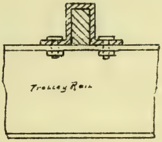
Eng 58 1

ANDREW B GRAHAM PHOTO LITHO WASHINGTON D.C.

...ed soldered to bolt.

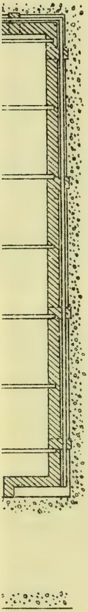
PLATE 2





Scale 1½ in. = 1 ft.

Detail at A

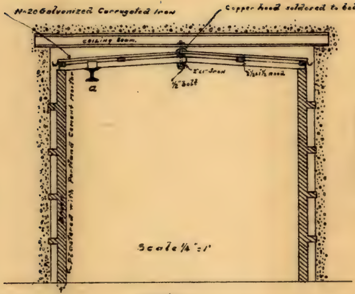


Sketch showing plan used for
Damp-proofing shell magazine.

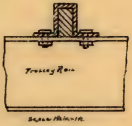
U. S. Engineer Office,
Jacksonville Fla., September 15th 1903.
To accompany Letter of date.
Francis R. Shunk
Captain, Corps of Engineers U. S.

Eng 58

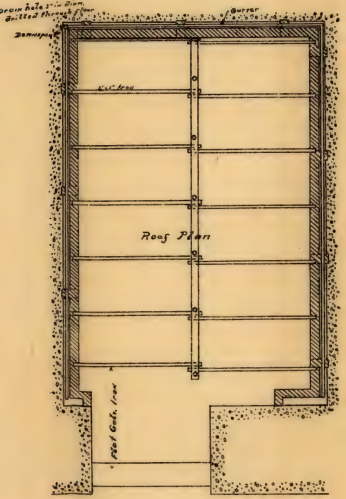
PLATE 2



Section



Detail at A



<u>Sketch showing plan used for</u>
<u>Damp-proofing shell magazine.</u>

U. S. Engineer Office,
Jacksonville Fla., September 15th 1903.
To accompany Letter of date.
Francis R. Shunk
Captain, Corps of Engineers U.S.A.

Eng 58 1

ANDREW B GRAHAM PHOTO-LITHO WASHINGTON D.C.

At a cost of about $15 per day a grading crew with this jet will move from 500 to 1,800 cubic yards of earth in a day, the amount depending upon the character of the bank and the slope to which it is graded.

It is believed that there should be added to each hydraulic grading boat a hydraulic dredge operated by a centrifugal pump to enable the grading of the bank to be carried on below the water's edge. One of the weakest points in the revetment system is the irregular position of the subaqueous mattress due to irregularity of the bottom.

Mattress weaving and anchoring.—The mattress, 70 to 90 feet wide and 12 inches thick, is woven continuously downstream on a barge fitted up for the purpose, lying normal to the bank, the inner edge of the mattress extending about 4 feet from the water's edge up the sloped bank.

A specially designed boat, 25 by 70 feet, is used in mattress weaving. The lower gunwale of this boat is high, the upper one low, and raked to offer less resistance to the current. From the upper gunwale a calked platform, 13½ by 66 feet, rises on a slope of 1 on 3½, giving a working surface for the weaving. On this sloping platform are placed launching ways of 3 by 8 inch stuff, spaced from 6 to 10 feet apart. At either end of the platform outriggers are built for carrying the mattress beyond the width of the boat. At the rear end of the launching ways and on a level with their tops a brush platform, 12 by 66 feet, extends lengthwise the boat. Its lower edge is flush with the lower gunwale of the boat and it is supported 8 feet inboard by stanchions. The boat is stiffened longitudinally by a truss.

On the sloping ways of this boat the mattress is woven. When the mattress has been woven to the top of the ways, the barge is pulled downstream from under the mattress until the edge of the completed mattress rests on the lower portion of the ways; weaving is then resumed where it was left off and carried on until the top of the ways is reached again. A continuous mattress is thus secured.

Straight, freshly cut willows, not less than 12 feet in length and from three-fourths to 2¼ inches in diameter at the butt ends, are used in the mattress. One cord of willow brush will make about 140 square feet of mattress 1 foot thick. These willows grow on the sand bars formed by the river and are the best material for the mattress, being very pliable.

For starting the mattress a continuous bundle of willow brush 12 to 14 inches in diameter is made of a length equal to the width of the mattress and well wrapped with wire strand. Into this bundle the butts of the willows are forced at an angle of about 35 with the axis of the mattress. The mattress is woven very much as straw is plaited for various purposes, three to five willows being used in carrying the stitch. The ends of the willows projecting over the inner and outer edges of the mattress are turned in and well woven into the mattress, forming strong selvage edges. The brush for weaving is brought in wire bundles and laid crosswise, butts upstream, on the platform of the mattress boat. The bundles are then opened and the brush is passed one or more pieces at a time to the weavers.

To give additional strength to the mattress, and for the purpose of anchoring it to the bank, a system of galvanized-wire strands, running lengthwise and crosswise of the mattress, is used. Both longitudinal and transverse members are composed of two ⅜-inch strands each, made of No. 11 wires. One of these strands lies wholly underneath and the other wholly on top of the mattress. Both longitudinal and transverse

wires are spaced 10 feet apart. All the longitudinal members are paid out under tension, as the mattress is made, from reels on the mattress boat, the top strand of each longitudinal passing through a fair leader suspended some 18 feet above the brush platform.

There are also transverse members of two $\frac{5}{8}$-inch strands each, extending one strand on top of the mattress and the other directly underneath it, from the outer selvage edge to deadmen on top of the bank back of the graded slope. They are laid out about normal to the axis of the mattress at a distance apart of 10 feet measured along this line. The transversals are run out from a reel on shore, the bottom part first, enough strand being pulled through past the outer selvage of the mattress to reach ashore when laid back on top of the mattress. Both parts of the transversals are laid just after the weavers pass the line, so that they are not woven into the body of the mattress. At all points of intersection of transversals with longitudinals the four parts of strand are brought together and fastened by stirrup bolts or clips of $\frac{7}{16}$-inch iron, but before the fastenings are made tight both parts of the transversals are put under tension from the outer-edge selvage edge to deadmen ashore by means of blocks and tackle. The deadmen are either rough blocks of stone, containing $2\frac{1}{2}$ to $3\frac{1}{2}$ cubic feet, or pile butts 12 inches or more in diameter and 4 feet long. The deadmen or anchors are planted 8 feet back of the top of the graded slope and from 3 to 5 feet deep, according to the character of the ground. From the top of the slope to the deadmen in place the strands lie in a narrow trench dug for that purpose.

The average day's work of a weaving crew is about 100 linear feet, costing from 60 to 70 cents per linear foot.

Sinking and ballasting mattress.—Specifications for standard revetment provide that three-fourths of a cubic yard of riprap stone per linear foot of mattress shall be used in sinking it to close contact with the bottom, the distribution being such that the weight per square foot of mattress increases from the shore out. It is also specified that an additional 50 cubic yards of stone shall be placed on 50 linear feet of mattress at the head and 1 cubic yard per linear foot on all laps. The stone is thrown from a barge, which is dropped downstream over the mattress with its outer end somewhat in advance of the shore end. It seldom happens that the full complement of stone is placed in sinking, as a sudden shifting of the barge is often necessary to prevent buckling of the mattress, especially in a swift current. It is therefore usual to go over it a second time. The sinking is not carried closer than 150 to 200 feet above the mattress boat, and as much as 1,000 linear feet, or even more, mattress is sometimes made before sinking is commenced. There is danger, however, in having so much mattress afloat, as a sudden rise may occur, and, though it might not otherwise damage the work, would possibly so foul the mattress with driftwood as to seriously impair its efficiency.

The operation of spawling the inshore edge of mattress precedes the paving of the bank, and consists of filling well the interstices of the mattress from its inshore edge to the contour 3 feet below standard low water with small spawls or quarry chips and fairing up with the same material the shoulder formed by the edge of the mattress where it lies on the graded slope. This spawling serves to stop wave action through the mattress and to solidify it against ice in the event of loss of the paving or ballast. About one-tenth of a cubic yard of spawls per linear foot is required.

Paving and spawling upper bank.—The upper bank from the contour 2 feet above standard high water to standard low water, and as much lower as the existing stage of river permits, is covered with a paving of riprap stone 12 inches thick at standard low water and 12 inches, 8 inches, and 6 inches thick, respectively, at the top of 1 on 2, 1 on 2½, and 1 on 3 slopes. A covering 2 inches thick of spawls or fine quarry chips is put on the paving, thus completing the revetment. The paving is done from the top of the slope down, the stones being set up edgewise and placed with some care to make a compact covering, so that when completed ready for the spawls it presents an appearance of a reverse shingling. In this form it is well adapted to resist wave action and dislodgment by ice, driftwood, or other forces to which it is likely to be exposed. The spawls, thrown on at and near the top of the slope, are raked down over the pavement, filling the interstitial voids and finding lodgment in the paving surface.

As will be seen from the above, the quantity of riprap stone for paving, as well as the spawls required per linear foot of bank, will vary with the height between the standard high and low water planes, the height of bank when lower than 2 feet above standard high water, the stage at which the work is done, and to some extent with the grade of the slope, but the paving stone will average close to one-half cubic yard per linear foot, and spawl covering less than one-third cubic yard for a height of 16 feet between high and low water planes.

COST OF REVETMENT CONSTRUCTION.

Elements of work and cost in detail of 8,748 linear feet of revetment in Pelican Bend during the fiscal year ending June 30, 1900.

Classification and extent.	Cost in item.	Total.
Grading bank (hydraulics), 8,550 linear feet, containing 60,452 cubic yards of earth:		
Supplies	$391.62	
Subsistence	500.03	
Labor	1,585.98	
Total cost, at $0.0409 per cubic yard		$2,477.63
Grading bank (slips and scrapers), 250 linear feet, containing 1,815 cubic yards of earth:		
Subsistence	29.44	
Labor	207.35	
Total cost, at $0.1304 per cubic yard		236.79
Construction and anchorage of mattress, 8,975 linear feet, or 779,705 square feet:		
Brush, 4,335.63 cords	9,626.83	
⅜-inch strand, 72,144 pounds	3,896.72	
Cable clips, 4,540	227.00	
Pine piling (dead men), 2,240 linear feet	352.32	
Subsistence	1,876.42	
Labor, weaving	4,420.31	
Total cost, at $0.0261 per square foot		20,399.60
Ballasting mattress and bank, 19,786 cubic yards of stone:		
Stone, 19,786 cubic yards	18,832.31	
Subsistence	1,804.95	
Labor	4,536.87	
Total cost, at $1.2723 per cubic yard		25,174.13
Spawling, 2,918 cubic yards of stone:		
Stone, 2,918 cubic yards	2,777.35	
Subsistence	265.86	
Labor	687.27	
Total cost, at $1.2784 per cubic yard		3,730.48
All other items incidental to construction		1,368.84
Grand total cost of 8,748 linear feet of revetment, at $6.10 per linear foot		53,387.47

Cost of works on Missouri River.—The cost of standard pile dikes and revetments necessarily varies so widely in different situations that unit costs can not be definitely stated. The following are the principal elements which enter the question of cost: Difference in elevation of high and low water planes, height of bank, distance of work from base of supplies, plant charges, extent of work and degree of concentration of same, season of the year in which carried on, condition of flow.

For preliminary estimates, however, $10 per linear foot may be taken as the average cost of three-row dike work and of standard revetment, including all office and incidental charges.

In carrying on numerous works at widely separated localities it has been found that field charges are distributed about as follows:

For actual construction, 67 per cent.

For care, repair, and moving plant, 22 per cent. (This includes an item of but 5 per cent for light repairs.)

Administration, 9 per cent.

All other items, including surveys and travel, 2 per cent.

MISCELLANEOUS WORKS.

B B B 19.

IMPROVEMENT OF THE YELLOWSTONE NATIONAL PARK.

[Officer in charge, Capt. Hiram M. Chittenden, Corps of Engineers.]

GENERAL:

*   *   *   *   *   *   *

GENERAL DESCRIPTION OF ROAD SYSTEM.

Main circuit or belt line.—As is well known, the object of the Government road system of the Yellowstone National Park is to give access to its natural wonders and attractions. The roads have no commercial purpose except such as may be incidental to this primary object. To a limited extent they may become thoroughfares for travel across the park both east and west and north and south.

While the entire region abounds in features of interest well worth visiting, there are six principal centers of attraction which are considered an indispensable part of every well-ordered tour. These are: Mammoth Hot Springs, the Norris Geyser Basin, the Firehole Geyser Basins, the Yellowstone Lake, the Grand Canyon of the Yellowstone, and the country near Mount Washburn and Tower Falls. The first three of these points of interest lie on a north and south line, approximately 20 miles apart. The other three lie on a similar line, 15 to 20 miles east of the first. A general circuit or belt line passes through these six centers, and at the points where the two sides approach nearest each other, namely, at Norris and the Grand Canyon, there is a crossroad connecting the two. The mileage of the belt line, including the crossroad just referred to, is about 154 miles.

Side roads.—Besides these more important points of interest there are many of less importance to which it has been considered necessary to build side roads. The principal side roads are as follows: Around

Bunsen Peak and to the Middle Gardiner Canyon, near Mammoth Hot Springs; the several side roads in the different geyser basins; the road to Sulphur Mountain in the valley of the Yellowstone River; the roads along both banks of the Grand Canyon of the Yellowstone; the road from Dunraven Pass to the summit of Mount Washburn, and the road from Baronett Bridge up the valley of the Lamar River to the northeast corner of the park. The total mileage of these side roads is about 62 miles.

Approaches.—To give access to the park from the outside, and particularly to the main circuit of the road system, approaches have been provided on each side. The first of these and the most important, although the shortest, is that from the north, extending from Gardiner, Mont., to Mammoth Hot Springs. The importance of this entrance arises from the fact that it is at this point that railroads can approach nearest to any of the principal centers of interest, and also that Mammoth Hot Springs is the business and administrative headquarters of the park, and the only portion to which access can be easily had in the winter season. This approach is controlled by the Northern Pacific Railroad.

The eastern approach touches the belt line at the outlet of Yellowstone Lake, and enters the park by way of Shoshone River and through Sylvan Pass, in the Absaroka Range. From the eastern boundary of the forest reserve, to the belt line the distance is a little less than 60 miles. About half of this distance is in the park proper. This approach is one of great scenic beauty, but owing to its length and the late melting of the snow in Sylvan Pass it can hardly become an important tourist route. It connects with the Burlington Railroad System.

The southern approach touches the belt line at the west shore of the Yellowstone Lake and comes up from the valley of Jackson Hole, which, with Jackson Lake and the Teton Mountains, forms one of the most important scenic attractions in the entire Rocky Mountain region. The distance from the outlet of Jackson Lake to the belt line is about 45 miles. From the south boundary of the park to the belt line it is about 23 miles. This road connects with the Government road built under a separate appropriation as a military road between Fort Washakie and Jackson Lake, and thus gives access to the Wind River Valley. The southern approach has at present no railroad connection.

The western approach lies in the valley of the Madison River and its two tributaries, the Gibbon and Firehole rivers. It forks at the junction of these two streams and follows each to the belt line. The total distance from the west boundary of the park to the nearest center of interest, namely, the Lower Geyser Basin, is about 21 miles. This approach connects, through an outside road about 70 miles long, with the Oregon Short Line Railroad.

Mileage.—The aggregate mileage of the park road system within the boundaries of the park is about 295 miles. The connecting Government roads in the forest reserve bring this mileage up to 405 miles.

It is not the policy of the Government to permit any undue extension of the road system, but to limit it to the actual necessities of reaching the more important objects of interest. So far as possible it is desired to maintain the park in its primitive condition without even the innovation of roads.

Trails.—For access to those portions of the park which lie off the

main road system bridle trails are provided. The main use of these trails is for Government scouts in patrolling the park, but they are also traveled a good deal by camping parties.

CHARACTER OF THE COUNTRY.

Mountain systems.—The country in which the Yellowstone National Park lies is mountainous, although the mountains are not as high or rugged as in certain other sections of the West. The main body of the park, in fact, is a rolling plateau surrounded by mountain ranges and has a moderate altitude of marked uniformity over the greater part of its area. The average altitude is about 7,700 feet. The average elevation of the principal mountains is about 10,000 feet and the highest peak is but a little over 11,000 feet.

The principal mountain range is the Absaroka Range, on the east, a very rugged system, which extends both north and south of the park for more than 50 miles. It also extends beyond the park boundary a considerable distance east, where its peaks reach a height of over 12,000 feet.

In the northwest corner of the park is the Gallatin Range, also a prominent system, the average height of the peaks being nearly 10,000 feet.

Southwest of the park and just touching its southern boundary is a very prominent system, the Teton Range, which contains the highest peak in this entire region.

Within the boundaries of the park are several detached ranges, including the Washburn Range, the Red Mountains, and the Big Game Ridge, on the south.

Besides these larger systems there are many smaller ranges of hills which extend in various directions over the park area.

Drainage areas.—There are three principal drainage areas in the park—the Missouri, the Yellowstone, and the Snake rivers. The Missouri system drains the northwestern and western portions through the Madison and Gallatin forks of that stream. The Yellowstone River drains by far the greater part, including the northern, eastern, and central portions. The Snake River drains the southwestern corner. The areas of these drainage systems are as follows:

	Square miles.
Yellowstone	1,900
Missouri	730
Snake	682

These rivers, with their smaller tributaries, comprise upward of 165 named streams which flow through the various sections of the park. As a general thing they are perennial in character, only a few of them drying up in the summer time. They add a heavy item of expense to the road work, although, owing to the stable condition of their beds, the question of foundations for bridges is a simple one.

There are many swamp areas in the park, but these are not generally where it is necessary to cross them, and therefore they are not obstacles of serious importance.

There are also extensive spring areas, many of which can not be avoided and are a source of considerable difficulty and annoyance in the spring of the year.

Forests.—At least 84 per cent of the park area is covered with dense

EFFECT OF FORESTS ON SNOW MELTING (1).

EFFECT OF FORESTS ON SNOW MELTING (2).

EFFECT OF FORESTS ON SNOW MELTING (3).

forest growth. These forests consist of evergreen trees almost exclusively, the principal varieties being *Pinus murrayana*, or lodge-pole pine; *Pinus flexilis*, the white pine; a related species, *Pinus albicaulis;* the Douglas spruce, *Pseudotsuga macronata;* the Engelmann spruce and silver fir, of the genera *Picea* and *Abies;* and two cedars, the *Juniperus scopulorum*, and a prostrate form, *Juniperus sibirica.*

Among the deciduous trees the most common are the cottonwood and poplar. The cottonwood is of a narrow-leafed variety, *Populus angustifolia*, and the poplar is the well-known *Populus tremuloides.*

The forests naturally play an important part in the development of the road system. The extensive amount of clearing adds a heavy item to the cost of road work. The trees are made some use of in the manufacture of lumber for bridges, although the timber is of an inferior quality. They furnish poles for telegraph and telephone lines and for fences and such fuel as is required in the park. The vast quantities of down timber found in all parts of the park are a great obstacle to travel off the beaten paths.

The influence of the forests upon the flow of the streams is of much importance, and in the matter of snow melting is not what is generally supposed. The forests increase the severity of floods arising from melting snow. Long experience in opening the roads in the park in the springtime has fully established this fact. The reason for it will be obvious as soon as attention is called to it, and the accompanying photographs will illustrate it almost to a demonstration.

During the season of snowfall the effect of the forests, in breaking the force of the wind, is to distribute the snow in an even blanket over the entire forested area. In the open country, where the wind has full sway, the snow is heaped largely into drifts, which accumulate in many places to depths of hundreds of feet. The sun has full effect in the open country, and with the approach of spring the snow gradually disappears under its rays, thawing during the daytime and freezing up again at night. The run-off from this melting snow oscillates back and forth, giving a diurnal fluctuation in the flow of the streams. The time of maximum daily flow depends upon the distance from the snow fields, but in the park is rarely later than 8 or 9 o'clock p. m. Dangerous floods never come from sun melting of the snow.

While this process is going on in the open country, the dense foliage of the forests prevents it in the shaded areas, and the snow there gradually settles down, becoming heavy and compact.[a] Long after the snow has disappeared in the open country, except in the drifts, it overspreads the ground everywhere in the forest at varying depths of from 2 to 5 feet. This condition continues until the warm winds

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[a] First picture of group shows an east and west road between Norris and the Grand Canyon. The second shows the snow in the forest along the same road. The third shows a large drift in the open country. All were taken the same day, June 13, 1899. In the open country fully 90 per cent of the area was already bare. In the forest the ground was everywhere covered from 4 to 6 feet. It will be noted in the first picture of the group (which was taken looking east) that the ground along the roots of the trees on the north side of the road is bare. This was where the sun's rays came down through the opening in the tree tops.

To this date there had been no flood, although the snow had nearly all gone in the open except in the drifts. The streams were full, but all within their beds. Two days after the above date a warm spell came, lasting more than a week. The forest snows melted with great rapidity. The streams were all flooded and much damage was done. In a short time, however, the forest snow was gone, but that in the great drifts outside remained several weeks longer.

and rains of spring arrive, with high temperatures during the night as well as the day. They have a maximum area to work upon, as the entire forested area is covered with snow. The result is that these water-laden snows melt and flow off in the course of a few days. If, as occasionally happens, periods of high temperature occur, lasting for several days, accompanied with warm rains, the rapidity of melting may be such as to cause destructive freshets, destroying the roads and bridges along the streams in the park and washing away many miles of railroad in the lower country. There being no drifts of consequence in the forests, the snow rapidly disappears when the warm winds come, and in a few days the ground is entirely bare. Out in the open country, on the other hand, the immense drifts remain into July and even August, and constitute an important source of supply. The effect of the forest, therefore, so far as snow melting is concerned, is to concentrate the run-off into a short period and thus increase the severity of the resulting flood.

The question of the extent to which the snow water in the forest sinks into the ground and thus creates an underground supply, which finally make its appearance in springs, is one by no means well understood, but it is believed that this effect is not as great as is commonly supposed. When snow begins to melt under the action of the sun, the water is largely taken up through capillary attraction by the snow itself, which is thus gradually converted from its original soft and light condition to one of density closely approaching water or ice. If the final melting takes place gradually, a good deal of the water undoubtedly soaks into the ground; but if, as frequently happens, there is a sudden melting, most of the water flows off into the streams.[a]

Another matter pertaining to forests which is not well understood is their influence upon precipitation. It is held by some that the high precipitation of the park (20 to 25 inches, as against 10 to 15 inches in the lower surrounding country) is due to its extensive forest areas. On the contrary, others hold that the high precipitation is mainly due to the great average elevation, and that the forest growth is itself a result, not a cause, of the increased moisture. Probably there is an element of truth in both theories.

The foregoing conclusions from practical observations upon the effect of forests upon snow melting should not in any sense be construed as an argument against forest preservation and extension. The influence of forests in controlling the run-off from rains, in preventing denudation, and in promoting the general good in many other ways is sufficient reason for their preservation, even if, in the case under consideration, their influence is not beneficial.

Character of the soil.—Except in limited districts in the north the park area consists of volcanic ejectamenta, the principal rocks being andesites, rhyolites, and basalts. Only the latter rock is worth much as macadam and its occurrence is too rare to be of general use. Some of the rhyolites are of hard texture, and there are certain places where these rocks and the basalts have been crumbled up into vast masses of small fragments, as finely broken as if they had gone through a rock crusher. Wherever practicable this fine rock will be used on the roads.

While there is not an abundance of rock that will make a good road surface, rock in situ abounds extensively and requires a great deal of

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[a] For relation of snowdrifts to road location see p. 2456.

blasting in building the roads through it. This is particularly the case over the entire portion of the Mount Washburn division.

A characteristic feature of the soil over large areas is the presence of black obsidian rock, which breaks up into fine particles on exposure to the air. When roads are first constructed of a soil containing this material they wear to a fairly good surface; but the action of the wind eliminates the soil after a time and leaves the obsidian particles. These have no binding quality, and consequently become, in the course of a few years, beds of loose sand. There is no remedy for this condition except to scrape the sand out of the road and cover it with new material.

In certain parts of the park there are large deposits of gravel, which afford excellent material for making a roadway, but these are not by any means general. In a good many places there are extensive deposits of sand, which have come from former action of water. This material is worthless as a road surface unless mixed with clay.

The volcanic rock assumes an almost infinite variety of form, both in its unaltered state and in its condition as decomposed by the action of hot water. In some places it forms a loam which makes a fairly good road in moist weather, but cuts up badly in wet or dry weather. In nearly all places where the road passes through what is called formation the soil is of a character which yields a fine white dust that is extremely disagreeable and difficult to control.

Climate.—In the matter of storms in the park no serious danger to the roads is ordinarily experienced. There are very few cloud-bursts and washouts. There are many landslides, but these are generally owing to the precipitous character of the ground and its small hold upon the subjacent rocks rather than to the action of storms. The undermining of these steep slopes by the road work causes them to slide, and in some places it will be necessary to alter the location of the road.

What may be called the wet season of the park extends from the time of opening the roads in the spring to about July 10. During this period there are frequent spells of wet weather, which work great injury to the roads. Snowstorms are frequent, and there is generally at least one snowstorm in September before the tourist season closes.

From about July 10 to September 10 the weather is generally dry, and this drought, as will be explained further on, is more injurious to the roads than the wet weather which precedes it.

Snow.—The snowfall in the upper park is very heavy, its light depth probably aggregating 20 feet. It plays an important part in the road work in the spring of the year. The tourist season opens before the snow is gone, and it is necessary to do a great deal of shoveling to get through the drifts. It is estimated that between 20,000 and 30,000 cubic yards of snow were shoveled last spring. But the main difficulty arises from the water that comes from the melting snow. This for a time makes it almost impossible to drain the roads effectively, and they are generally badly cut up before the snow is gone.

In this connection it may be stated that it has been found important, along certain east and west roads in the high altitudes of the park, to about double the width (30 feet) of the original clearing. It has been observed that while the snow still lies from 4 to 10 feet deep in these roads at the approach of the tourist season the ground is entirely bare at the roots of the trees on the north side, where the sun's rays come

down through the opening in the tree tops caused by the clearing. In order to transfer this effect to the road surface, the swath through the forest was last winter doubled in width along the road between Norris and the Grand Canyon. The beneficial effect of this provision was very apparent the following spring.

It may be noted that a considerable part of the snow disappears in evaporation. The matter of evaporation from the surface of snow and ice has never received thorough investigation, but observation throughout this country shows that it is very rapid. Snowdrifts are frequently observed to disappear with scarcely a perceptible flow from them and with the soil apparently dry a short distance away. This applies more particularly to the smaller and lighter drifts rather than to those great accumulations which abound so extensively throughout this country; but there is no doubt that in all cases evaporation carries off a large proportion of the snow.

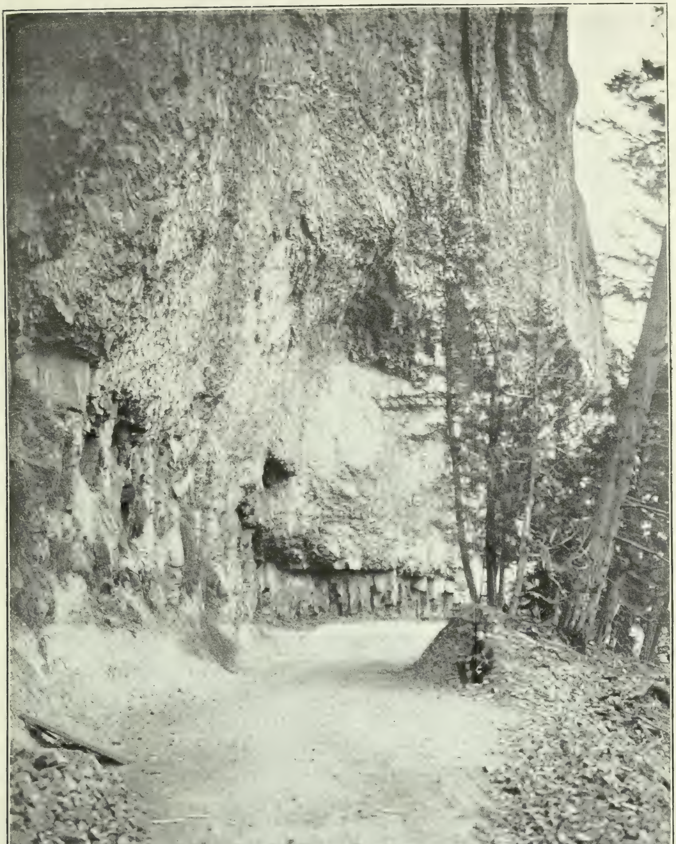
On the main system there are few places where avalanches occur, but in the neighborhood of Sylvan Pass there are a good many. These avalanches are practically harmless to the roads, because the valleys where they occur are well filled before the snow begins to slide, and it does not generally reach down to the ground. The worst result is the heaping up of snow, which takes a long time to melt in the spring.

LOCATION.

Acquaintance with the country.—The matter of road location is, of course, one of the most important features in the whole problem of road building. Unlike the matter of construction, it is not one which can be governed entirely by money. A great many considerations enter which money will not control. The most important of these is a thorough acquaintance with the country through which the road is to pass, extending over a sufficient time to give an accurate knowledge of its physical characteristics, the location of snowdrifts and marshy places in the spring of the year, the character of the streams, and a great many other things which a simple survey will not disclose. A lack of this thorough knowledge invariably leads to defective locations, which sooner or later have to be changed.

Funds for construction.—Another matter which almost always enters the question of road location is that of the funds available for construction. The best location often involves very heavy expense of construction, and if the funds for this work are not available it may be necessary to select inferior locations, where the work will be less costly. This was particularly true in the early work in the park. The funds then available were barely sufficient to open the roads over the easiest ground for construction, and consequently the location was everywhere defective and has since been largely replaced. The same experience is true of nearly every railroad built in the West. The Union Pacific and Northern Pacific have made extensive changes in their original locations, amounting, it is believed, to between one-fourth and one-third of their entire mileage. This condition has been, in fact, a necessary one in the development of every new community. The first essential has been to get the roads through in some way in order that the public might have their use at the earliest possible moment. Then, as communities have increased in numbers and wealth, it has been possible to improve on these original locations and to make expenditures which would have been entirely impossible at first.

ROAD IN GARDINER CANYON.



OVERHANGING CLIFF NEAR TOWER FALLS.

Primary considerations.—In the location of roads built solely for commercial purposes the first consideration is to secure the most direct line and the easiest gradients between the points which the road is to connect. Other things being equal, the shortest road is the best one. A straight line, however, between objective points is rarely possible, because topographical features will not permit it. The final location will be governed by the limit of gradients allowable and the location of obstacles, such as swamps, streams, etc. It will be, in fact, a compromise between the question of gradients, distance, and the cost of passing obstacles.

In the park work different considerations come in, because the roads are not for commercial purposes, but for viewing natural scenery. It is therefore a prime object to locate them so as to give the best views and pass near the important attractions.

The following are examples of locations designed to afford good views of natural scenery, where they would have been different if made solely for commercial purposes:

The road through the Travertine Rocks, 2½ miles above Mammoth Hot Springs, was mainly for the purpose of making accessible a very remarkable natural formation.

Shoshone Point, on the road between the Upper Geyser Basin and Yellowstone Lake, is another example. The road is here brought over a high point which gives a view of Shoshone Lake and its entire watershed, with the Teton Mountains in the background. A better location, as a commercial highway, could have been found farther down the hill.

Lake View, about a mile west of the "Thumb" station, and a similar point on the Natural Bridge road are points from which fine views of the Yellowstone Lake and surrounding country come unexpectedly to the notice of the tourist upon rounding sharp bends in the dense forest. Trees have been cleared away in both cases to afford better views.

On the east road the location was carried to higher ground in two instances for the purpose of affording fine views of the Yellowstone Lake, Red Mountain Range, and the Teton Mountains.

On the same road the line just east of Sylvan Pass was carried across a swampy clearing in order to give a view of Avalanche Peak, although better ground for the road could be found in the edge of the timber on the border of the swamp.

The road near the Upper Falls of the Yellowstone River was carried along the brink of the river, although a much cheaper location could have been found farther back, but would have sacrificed the fine scenery of the Yellowstone Rapids.

The road from the Canyon Hotel to Inspiration Point is carried all the way along the brink of the canyon, where a much cheaper location was available a little farther back.

The entire length of the "loop" over the summit of Mount Washburn is for developing the fine scenic views from that mountain. In this case a low line has been located for through traffic where viewing the scenery is not an object.

The location of the road from Tower Creek for a distance of about three-fourths of a mile south has made accessible the exceptionally fine views in that section. The same is true of the crossing of Tower Creek. A much cheaper line could have been chosen.

Curves and tangents.—It is generally considered that a winding road is more beautiful than a straight one, and the explanation ordinarily

given is that curves are more pleasing than straight lines. As a matter of fact, the desirability of either curves or straight lines depends upon the situation, and is a question of adaptation to the ends in view. The road which gives the most pleasing appearance is that which fulfills its purpose with the least effort. For example, a straight line passing over a rolling country always offends the eye, because it involves an unnecessary going up and down hill. A winding road, on the other hand, which avoids the hills by curving around them, gives a pleasing impression, because it accomplishes its purpose with a minimum exertion. For a similar reason, a winding road across a perfectly even plain is objectionable, because it involves an obvious waste of effort. Wherever, therefore, there is no obstacle in the way of moving on a straight line such a line gives a better appearance to the eye. Wherever there is a curve in the road there should be some obvious reason for it, as an obstacle which it is necessary to pass around. Even in formal city parks, where walks are nearly all curvilinear, artificial obstacles, such as flower beds, groups of trees, etc., are so disposed as to make the curves appear both natural and necessary.

Another reason why curved roads are more interesting, as a general thing, than straight ones is that the view ahead is limited and the traveler is thus constantly on the alert to see what will develop around the next turn. The effect of such a road is to maintain a constant interest and to divert attention from the discomforts of the way. The same reasoning applies to a properly located straight line. For example, in coming to an open plain, where the eye can take in its entire expanse, there is nothing new awaiting the traveler until he reaches the farther side, and anything which delays this end, as an increase of distance caused by unnecessary curves, simply augments the tedium of the journey.

In the roads of the park curves naturally predominate because the country is of a mountainous character and very few situations exist where long tangents are possible. Among the more important tangents may be mentioned one of about a mile in length lying mainly between the sixth and seventh mileposts on the road from Mammoth Hot Springs to Norris, and two near the Fountain Hotel, where the road crosses broad plains. All of these tangents fulfill the above conditions perfectly, because the country is in each case a comparatively even plain, over which a winding road would be objectionable. Examples of tangents where the road should have been winding may be seen on the line between Norris and the canyon, which contains the most defective locations in the entire park. There are two tangents on this road, each over a mile long, cutting straight across hills with an up-and-down appearance which is very offensive to the eye. A similar tangent on the east road, and the longest one in the park, being about two miles, combines the above defects and advantages, part of it being located over an open plain, and part of it over a rolling wooded country, where the line should have been adapted to the contour of the ground. On this same road there are three other tangents, each about three-fourths of a mile long, which fulfill the conditions of correct road location.

In public highways sharp curves are allowable, and anything above a radius of 50 feet can be traveled at a brisk trot without danger. Nearly all the curves in the park-road system are of 75 feet radius or greater. There are two in the Gardiner Canyon, one in the Traver-

VIEW ON MOUNT WASHBURN ROAD.

LONG TANGENT THROUGH FOREST ON EAST ROAD.

SIDE HILL LOCATION, MOUNT WASHBURN ROAD.

tine Rocks above Mammoth Hot Springs, two in the Golden Gate Canyon, and several on the loop over Mount Washburn at the turning points on the zigzag up the mountain that do not exceed 50 feet radius.

Gradients.—The question of gradients, upon which the location of a road largely depends, has received a great deal of attention in the park work. The result of long experience with the earlier roads has been the adoption of a definite limit of 8 per cent on the main system. In the earlier work no attention seems to have been paid to this matter, the gradients being run up to the very limit of the capacity of horses to haul loads. Some of these old roads had gradients of over 20 per cent.

The considerations which led to the adoption of an 8 per cent limit were as follows: The roads being mainly for tourist travel, the question of speed is of greater importance than on roads devoted mainly to the hauling of freight. It is found from experience that when a gradient exceeds about 4 per cent loaded coaches will slow down to a walk. When it comes to walking, a team will ascend an 8 per cent gradient very nearly as rapidly as a 4 per cent. In this way the necessary elevation is more quickly overcome, a lighter gradient is reached, and an increased speed is more quickly possible. It therefore promotes speed of traveling to shorten the distance by increasing the gradient up to a certain limit. With descending traffic it is found that on gradients which exceed about 8 per cent it is not safe to drive teams at a rapid trot, and the difficulty of holding back heavy loads becomes a matter of serious importance. All these considerations have led to the adoption of the above limit of gradients. Even with this limit there are many situations in the park where continuous gradients are 3 and 4 miles long, and in one case nearly 10 miles. Inasmuch as an 8 per cent gradient requires a brake to assist in controlling descending traffic, and as the constant application of the foot to the brake involves a serious strain upon the driver, it is important that these continuons gradients be broken here and there by nearly level stretches in order to afford occasional relief to drivers. In ascending traffic they give the teams relief from the continuous strain of pulling.[a]

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[a] Extract from a paper by J. W. Abbott, special agent in office of public roads inquiries for western division, 1900:

For pleasure driving the grade, where practicable, should not exceed 4 per cent. A good horse with a light buggy and two persons will trot easily up a 4 per cent grade and as easily down without a brake. With a higher gradient the strain in either direction becomes increasingly apparent.

For freight traffic the maximum grade admissible is 12 per cent. Four animals, together with the one or two wagons used on a mountain road, are all that one driver can safely and properly handle on steep grades. When he uses two wagons, lead and trail, at every stop ascending he must hold both wagons by the brakes on the lead. In descending with heavy loads, excepting when the roads are icy, he must control his wagons with brakes on both, the lead by the lever beside his seat, the trail by a strap leading to the brake lever. When the road is icy, he must control the descent by rough locking one or more of his rear wheels. To rough lock he attaches some rough device, like a piece of chain or a short steel runner, grooved on the upper side to fit the tire, and projecting prongs on the lower, to the felly of a rear wheel, just in front of the point where it rests upon the ground. A chain attached firmly to the center of the forward axle is then tightly fastened to this rough lock. Thus secured, as the wagon descends the hill, the wheel remains rigid and the rough lock plows into the surface of the road.

Experience in heavy freighting has shown that wagons can be actually and satisfactorily controlled in all weathers on 12 per cent grades, but that they can not be

A change of gradient on a straight road is invariably unpleasing, producing the effect of hills and hollows where uniformity is more desirable. In the park work it is a rule to place these changes of gradient on curves wherever practicable, and they thus attract no attention.

Rolling roads.—It a theory commonly held among the drivers in the park that a rolling road is easier upon teams than one of uniform gradient, even if nearly level. Their explanation is that a rolling road

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thus controlled on steeper grades, and that where much heavy freighting has been attempted on steeper grades it has almost invariably been attended with terrible accidents. In freighting on any grade the weight and number of wagons will depend upon the proportion between material to be hauled up and freight back. On a properly constructed dry road four animals, averaging 1,300 pounds each in weight, will haul 6,500 pounds total weight, distributed between wagons and contents, up a 12 per cent grade at the rate of about 1½ miles per hour. Descending, the four animals will haul all that a wagon can hold up, but in practice this amount rarely exceeds 16,000 pounds on a single wagon or 20,000 pounds on a lead and trail, and the average is probably not much in excess of 10,000 pounds on one wagon or 14,000 pounds on lead and trail. When roads are icy heavy wagons tear up a roadbed badly.

But while a 12 per cent grade is admissible as a maximum, roads of lighter grade are so much more efficient and satisfactory in every way that only the gravest necessity should ever determine the maximum at 12 per cent.

Mountain roads are routes of travel between points of different altitudes. The most common as well as the most serious mistake made in their location is the attempt to cover this distance by too short a line. On a 12 per cent grade every pound of freight going up is elevated 12 feet for each 100 feet of horizontal distance traveled. On an 8 per cent grade it is elevated 12 feet in 150 feet of horizonial distance traveled, while on a 6 per cent grade it is elevated the same amount in 200 feet of horizontal distance; or, in other words, the distance required to get a 12 per cent grade must be increased one-half for an 8 per cent grade and doubled for a 6 per cent grade. Tables have been published giving the comparative weights which a horse can pull on different gradients; but, so far as the writer knows, no actual statistics have ever been compiled which show what would be the difference in performance in actual freighting between good roads of different gradients. The limit of load which a team can pull on any road is determined by the steepest place on that road. It is rare that a mountain road is built on which the maximum gradient is less than 12 per cent. It is also true that there are very few places where mountain roads have been constructed that it was not feasible to secure a maximum under 12 per cent. The extra length that would be required is generally much less than one would at first suppose. Roads built on a continuous uniform grade are very rare. Many seem to go up steep places just for the sake of going down again, thus giving a grade adverse to the heaviest traffic. which ought never to be compelled to climb a foot in descending a mountain. So far as the writer's study and observation have extended, 99 per cent of all roads built for heavy mountain traffic might have had a maximum under 12 per cent. It is putting it very moderately to say that a team will haul up 50 per cent more load in the same time between two given points on a road with an 8 per cent maximum than it could haul on one of similar surface with a 12 per cent maximum.

Besides the advantage in upfreighting, the 8 per cent road possesses many favorable points which are liable to be lost sight of. It is vastly safer for both light driving and freighting. On passenger vehicles brakes while desirable are not essential to safety. With heavy loads if the brake fails there is a fair chance of escape for driver, team, and wagon. Such a road is not seriously damaged by rain and melting snows, which work much injury on steeper grades; damage from rough locking is enormously reduced, and as such practice can be to a great extent avoided the time thus consumed is saved. Repair bills on wagons and harness are lessened, and the life of wagons is greatly prolonged. It is a pleasure to drive down an 8 per cent grade, as it produces a sense of exhileration which most people find agreeable. As gradients become steeper the sense of danger grows more and more keen. The writer believes that 8 per cent is the gradient to be aimed at where important differences in elevation are to overcome, and that such gradient can generally be secured. As a rule, in such cases a lower gradient means too long a route without commensurate advantage, while a higher means an unnecessary loss in the very purpose for which a road is required. The maximum adopted in the old Government pike crossing the Alleghenies was 7 per cent.

VIEW, MOUNT WASHBURN ROAD.

RETAINING WALL IN UPPER GIBBON CANYON.

calls into play different sets of muscles in the animals and gives occasional relief to those which have been for some time under a continuous strain. It is not likely that this theory is founded in fact, inasmuch as a rolling road involves steeper gradients and heavier draft upon the animals. The real explanation is of a different kind. Where a road has a uniform gradient drivers are apt to push their animals more continuously than on one which is broken by occasional elevations or depressions. Wherever hills occur they afford convenient excuses for bringing the teams down to a walk and thus giving a respite from continuous trotting. On a perfectly even road these obvious excuses do not exist, and the drivers, fearing impatience on the part of passengers, keep their teams in continuous rapid motion. The result is that the animals do not have the opportunity for resting that they do on a rolling road.

Adaptation to ground.—It was a common practice in the early work not to avoid hills which it was possible to climb over, and no effort was made to adapt the road to the conformation of the ground so as to secure a regular gradient. The result was a great increase in the difficulty of traveling, and a great sacrifice of the scenic value of the roads. Where a road is carried, as it should be, sidewise along a hill to gain the necessary elevation instead of going straight over, a view is always afforded over the country on the lower side. Such locations, therefore, contribute to the advantage of sightseers.

It is a further observation worth noting that roads which fit the ground and adapt themselves to the topography are more pleasing to the eye than those laid out on regular mathematical curves. The latter method always involves heavy cuts and fills, while the former avoids them. In railroad work regular curves are a necessity, but in highway work it is more important to take the ground as it is than to endeavor to fit regular curves to it. In this connection it may be noted that heavy cuts and fills on a curved road generally detract from its appearance, while on a straight road they add to it by eliminating the up and down appearance which is so objectionable.

Old and new locations.—The park road system will probably always contain some defective locations. As already stated, little attention was paid to this matter in the earlier work, and lack of funds compelled the adoption of inferior locations. In later work the desire to utilize as far as possible what had already been done has led to compromises which do not satisfy the engineer and would be a subject of adverse criticism in ignorance of the reasons for them.

In the more recent location of the park roads the long continuance of a single administrative head has made it possible to give the necessary study to the country for the determination of the best location. For example, the road between Mammoth Hot Springs and the Grand Canyon, via Tower Falls, a distance of over 40 miles, has been traveled over many times by the officer in charge, who has been able in this way to study the situation at all seasons of the year, and to determine in his own mind the location which will best satisfy all conditions. With this knowledge he indicates to the surveying party frequent points which the road must pass and requires them to fill in the details between. It is believed that the location of the above road utilizes nearly every advantage which the topography of the country affords.

Surveys.—It has not been the practice on this work to expend much money in actual surveys. The general location of the roads has been

so obvious that extensive reconnaissances have not been necessary, and there has not generally been any survey work until the actual time of construction has arrived. Then it has been the practice to attach small survey parties to the working crews for the purpose of setting grade and construction stakes immediately in advance of actual work. One transit man and two rodmen are sufficient for a single party, and as they mess with the working crew the expense of a separate organization is eliminated.

Snowdrifts.—As the roads are not traveled at all during the winter season, except between Gardiner and Mammoth Hot Springs, the presence of snowdrifts is a matter of importance only during a short period at the beginning of the tourist season. For this reason little attention is paid to the matter of avoiding drifts, and it is not generally considered advisable to change the location of a road which is otherwise good simply because it happens to pass where the snow drifts heavily. This is particularly true if such changes would increase the length of the road. The disadvantage from having to travel this increased distance during the entire season would more than offset the drawback from the presence of the drifts during the short period at the beginning. There are, however, a few localities along the Yellowstone River where the accumulation of drifts is so extensive that it will be necessary to change the location of the road.

CONSTRUCTION.

Plant.—The road plant consists of all modern improved machinery, including a portable rock crusher, portable sawmill, pile driver, steam road roller, plows and scrapers, grading machines, wheelbarrows, and picks and shovels.

Clearing and grubbing.—The general method adopted for clearing the roadway through forests is to grub around the roots of the trees and cut off the main roots 3 or 4 feet from the stump. A line is then attached to the tree at a distance of 15 to 20 feet above the ground and the tree is pulled over. Most of the timber consists of lodgepole pine, and the trunks are too slender to permit pulling the tree over without previously cutting the larger roots. After the tree is down the roots are pulled out, and the ground is then ready for the grading plow.

It is desirable to move all the timber from the clearings to a distance that will place it out of sight of the road, but in many localities the down timber is so dense that it virtually requires the building of a new road to haul the timber away, and this increases the cost to such an extent that it has not yet been found practicable to remove the timber except in a few favored localities. It would be a great improvement to clear away the down timber to a distance of 100 feet on each side of the road, and to thin out the trees somewhat so as to permit the growth of grass. Besides beautifying the roadside, it would give a feeding ground for game near the highway, and would probably lead to their being seen more frequently by the traveling public.

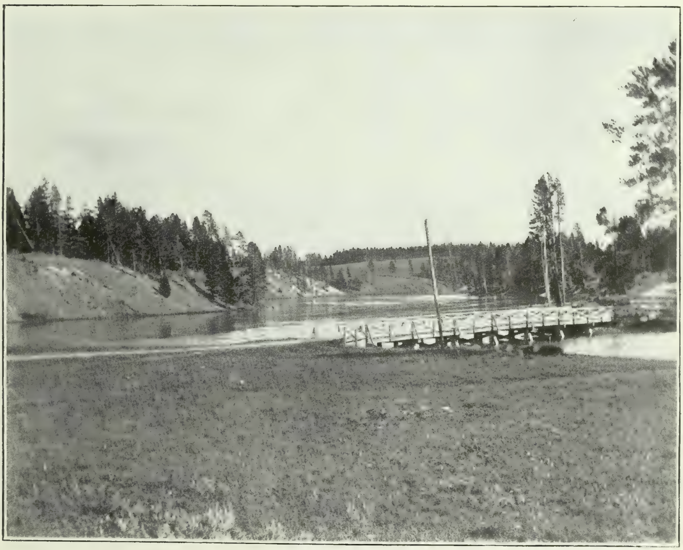
Rockwork.—Both dynamite and black powder are used in rock blasting, depending upon the situation and the purpose in view. The drilling is all done by hand, generally with the jumper drill, more rarely with the churn drill. In blasting detached pieces of rock with only one hole the ordinary time fuse is used; but with large masses of rock the Smith Igniting Dynamo, capable of firing fifteen holes, is employed.

RETAINING WALL AT GIBBON FALLS.

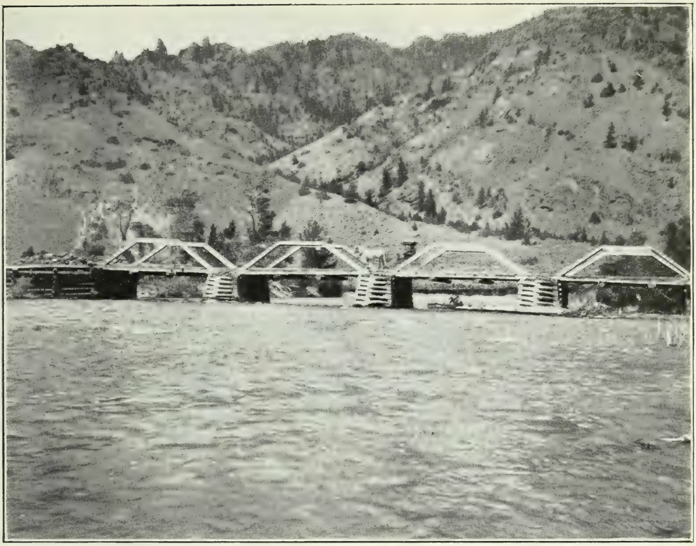
RETAINING WALL ALONG GARDINER RIVER.

RETAINING WALL UNDER HIGH CLIFF NEAR TOWER FALLS.

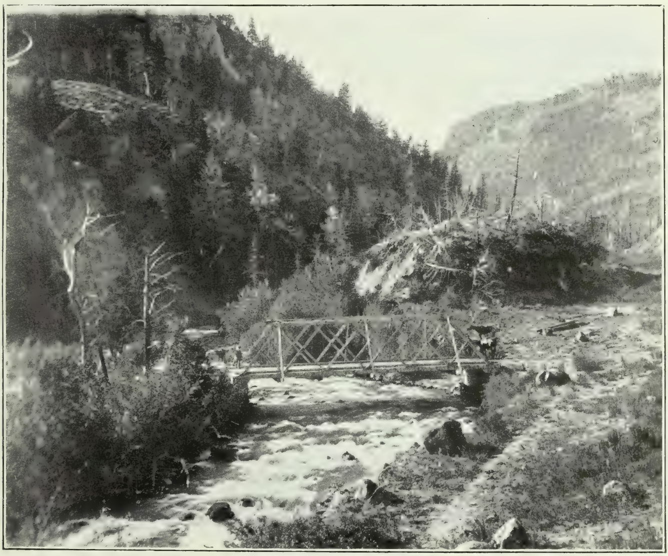
BRIDGE OVER BUFFALO FORK.



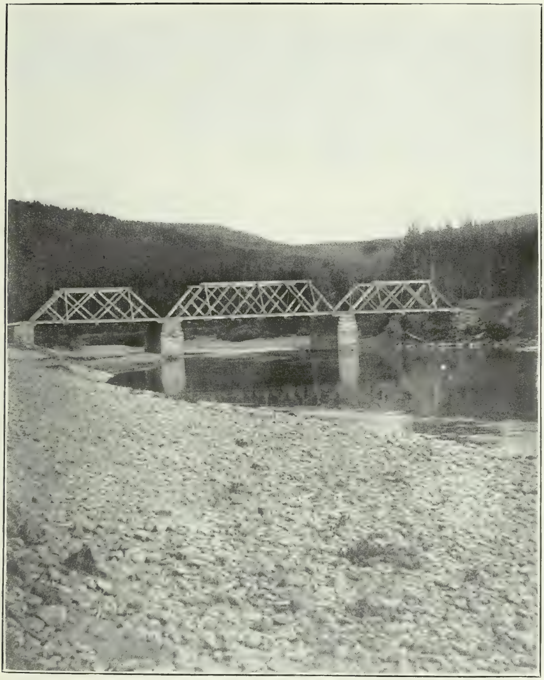
OTTER CREEK BRIDGE.



BRIDGE OVER THE SHOSHONE RIVER ON THE EAST ROAD.



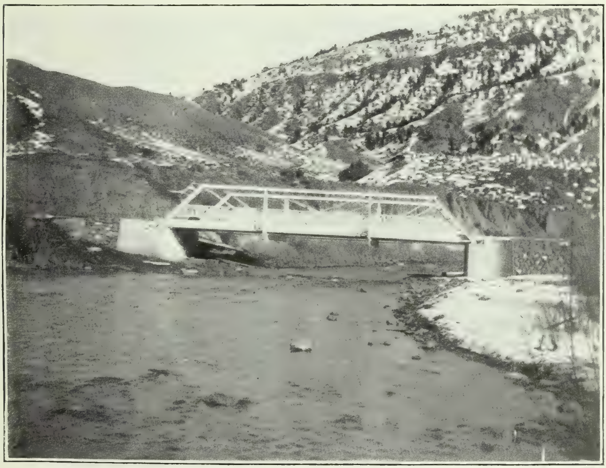
WOODEN TRUSS BRIDGE, GARDINER RIVER.



BRIDGE OVER SNAKE RIVER.

PILE BRIDGE OVER THE YELLOWSTONE AT LAKE OUTLET

WOODEN ARCH OVER DRY RAVINE ON LEFT BANK OF THE YELLOWSTONE RIVER.



BRIDGE NO. 4, GARDINER RIVER, SHOWING SOLID CONCRETE ABUTMENTS.

STEEL ARCH, CASCADE CREEK.

Grading.—In laying out the work for grading, the effort is, of course, always made to have cuts balance the neighboring fills, so as to reduce the work to a minimum.

Retaining walls.—Where retaining walls have been found necessary, they have so far been built exclusively of dry masonry, except the two wing walls which connect the entrance gate at Gardiner with the park boundary; these are laid in hydraulic cement mortar. The old retaining walls were built in a careless way and have given great trouble. The material for walls throughout the park is very inferior, partly because of the quality of the rock and partly because it occurs mainly in bowlders without good beds. In later work more pains have been taken in laying these walls, and there are at present several fine examples on the road system. The accompanying photographs show the more important.

Ditches.—The matter of drainage is not one of great importance except for a short time at the opening of the tourist season. The absence of moisture from the roads is a greater drawback during most of the season than its presence. Subdrainage of the roadbed is wholly unnecessary.

The side ditches are considered by the people doing business over the roads as a source of considerable danger, and there is constant pressure to have them eliminated, so that in case of runaways it will be possible to drive out of the road or against a high fixed bank. The stage managers desire that at least one side of the roads shall be safe from accident in the event of a runaway.

Corduroy.—There are several locations on which corduroy has been resorted to, as a general thing, for temporary purposes, but occasionally as a permanent form of improvement. Where a road crosses a swamp in which water stands permanently there is no better foundation than a layer of logs, provided these are sunk far enough into the water to be kept continuously wet. The most extensive example of this class of work is the crossing of the Pelican Valley, on the east road, about a mile east of the Yellowstone River. The distance across the swamp is about half a mile, and the road is laid upon logs about 30 feet in length, sunk well down into the water of the swamp. Upon these logs an embankment 3 to 4 feet high has been built.

Bridges.—The bridges were originally all built of wood, but those now being put in on the main system are of more durable material. In those sections near the railroad, where the hauling of material is not a matter of great cost, monolithic concrete abutments are used. These give the most satisfactory and permanent results of any form of construction. Farther out in the park, where the cost of hauling becomes an important item, a practice has been begun of building concrete abutments under the ends of the trusses in the form of the frustum of a pyramid, filling in the space between them with dry masonry. While this is not as satisfactory as the monolithic construction, it gives fairly good results.

Steel is being generally adopted for the superstructures of bridges on the main system. Several varieties of design have been fitted to special situations, such as the ordinary through truss, one large deck truss, a large steel arch, and one combination five steel arches. The largest of these bridges is the one over the Middle Gardiner River, 410 feet long, with an average height of about 60 feet. The most important bridge, however. is the steel-concrete arch over the Yellowstone River,

of which a more particular description will be given later on. The Golden Gate viaduct is an example of an original type of construction which will also receive special consideration later.

The decking of the bridges consists of two courses of lumber, one being laid at right angles to the axis of the bridge and the other obliquely with or parallel to it. The latter method has come into use in recent years and is believed to be better than the general custom of laying decking either transversely to the axis of the bridge or obliquely with it. It gives an easier surface for the carriages to travel over than when they cross so many joints, and the wear all falling upon a few plank, these can be replaced without disturbing the rest. On wooden bridges it has been found desirable to make the guard rails of round timber, as they are much less liable to warp and have greater strength in resisting the weight of the snow in winter.

Fords.—Formerly there were many fords on the road system, but by the end of another year they will all be eliminated.

Culverts.—One of the greatest sources of difficulty and annoyance, both in the construction of the park roads and in their subsequent maintenance, has been the culverts. These were originally put in in excessive numbers. Wherever there was any evidence of moisture a culvert was put in instead of endeavoring to lead the water along the ditch to some low point in the road and then carrying the drainage of a considerable length of road through a single culvert. The great number of these culverts and their perishable character were a source of constant annoyance and danger in travel. In late years large numbers of them have been eliminated altogether and the practice now is, on the main system, to replace the necessary ones with vitrified clay pipe. The dimensions used are 24 inches, 18 inches, and 12 inches, the great bulk of the pipe being of the latter dimension. The fixed rule for placing this pipe is to cover it with at least 18 inches of earth, in order that there may be no danger of breaking from the pressure of wheels.

Road surface.—The matter of securing a proper surface for the roads is perhaps the most difficult and expensive feature connected with their construction. This arises from a general absence of suitable surfacing material, particularly in those portions of the park that run through the hot springs districts. There is but little good gravel in these sections, while the rock itself is of a friable character, which is of little use in resisting the wear of wheels. The problem is therefore a difficult one, the proper solution of which will ultimately require a great expenditure of money. The use of regular macadam is exceedingly expensive, and the occurrence of a suitable rock is so rare that it is hardly probable that this system will be generally adopted in the near future. At present the most practicable method is to study the effect of different soils through which the road passes, and wherever one is discovered that wears well under traffic to open a quarry and use it as far as it can be economically hauled in both directions. Combining this method with the sprinkling system, to be described further on, gives, on the whole, very satisfactory results. Considerable stretches of the roads have been treated with macadam, a Blake rock crusher being used in its manufacture.

In connection with the resurfacing of the roads, a 10-ton steam roller of the most approved modern pattern has been used with excellent

results. It is hardly practicable, however, to use it extensively during the tourist season on account of danger of frightening teams.

Cross slopes.—It is generally considered proper practice to slope side-hill roads toward the bank, so that all surface drainage will go into the ditch and thus avoid eroding the embankment and also to make the road safer if very narrow and built along steep hillsides. This practice is objectionable so far as use of the roads is concerned. It is hard on animals and vehicles to travel on a sideling road and more wearing on the road surface. A road should be built like a railroad track, without slope either way (except that due to rounded surface), on straight lines, and with the outer side raised on curves. Both the appearance and use of the roads are improved in this way.

Cross drains.—The practice, often observed on public highways, of building cross ditches on long hills, so as to stop the drainage that may flow down the roads and give resting places for ascending loads, has never been followed in the park. These cross drains are so objectionable in rapid downhill travel that it would be impossible to tolerate them.

Signposts.—In a place like the Yellowstone Park signboards are a necessity for the convenience of the traveling public. Only mileposts and those denoting junction points are cared for under the appropriation for improving the road system. Mileposts are of turned cedar, 6 inches in diameter, with conical tops, and are set 18 inches in the ground. Signs are placed on opposite sides denoting the distance to the nearest stopping places. For example, in approaching a milepost the number read denotes the number of miles to the stopping place next ahead. Only whole numbers are used, the distance between any two points being taken and the nearest even number of miles assumed, omitting all fractions. The miles, therefore, are not strictly correct, being a little more or a little less than true miles.

At each important junction point signboards are put up denoting the direction and distance of important diverging points.

Lumber manufacture.—In the construction of bridges and other structures much reliance has been placed upon native lumber, although it is not of first-class quality. In the manufacture of this lumber a portable sawmill is used, capable of turning out from 6,000 to 10,000 feet per day. The average cost of manufacture, including all expense of repair, moving, etc., is about $15 per thousand.

The timber chiefly relied upon, or at least most desirable, is the Douglas Spruce (*Pseudotsuga macronata*), but it does not abound in sufficient quantity for required needs, and therefore other timber of less desirable quality has to be resorted to.

Method of work.—The work upon the park road system is conducted entirely by hired labor, except that the teams are hired under contract. Supplies are, of course, purchased by the usual method of proposals, and the larger purchases, like those of bridge steel, are made under formal contracts. It is found that the work itself can not be conducted to advantage by contract. The reasons for this are numerous and convincing. The Government has a large and well-equipped plant ready for instant use. Its method of subsisting its employees has developed into a regular system. The rate of wages is that of the surrounding country, and the hours are fixed by law. A contractor is forced to conform to the Government rates to hold his men. If he adds a profit to

the cost he can not compete with the Government, and if he cuts off the profit he can not live. Moreover, contractors find that the park regulations embarrass their freedom of action in many ways, and the rough and untidy outfits generally used are objectionable along the lines of travel. Finally, the work itself is of a character that makes it impossible to specify it with sufficient definiteness for contracts. This is particularly true of repair and maintenance work, and of construction work itself where lack of funds permits only partial work at first, leaving completion to the future. All these considerations make it impracticable to execute this work by contract, and every attempt to do so has ended in failure. Moreover, with the very complete organization which it now has and its general system of conducting operations as the outgrowth of years of experience, together with its numerous experienced foremen who have become familiar with the country and method of work, the Government can itself do this work more cheaply than it can contract for it.

The headquarters of the Government work are at Mammoth Hot Springs, where the main office, shops, and storehouses are located.

The working parties are subsisted entirely in camp. The organization of a party of, say, seventy-five men is as follows: One overseer in general charge of the camp, with two suboverseers to assist him; one blacksmith; one cook and two helpers; one timekeeper; one water boy, and one night herder constitute what might be called the staff of the party, the rest consisting of laborers of different classes. The crews are subsisted upon a regular fixed ration of high quality and ample quantity. The supplies and all material are purchased and stored in the warehouses at Mammoth Hot Springs, from which they are distributed to the parties in the field. The subsistence supplies are issued about every ten days. As there are frequent changes in the organization of the parties, the ration does not ordinarily apply without some modification, and has to be supplemented by smaller issues, which are sent out as occasion arises. The cost of subsistence, including provisions, freight and hauling, wages of cooks and helpers, falls between 40 and 50 cents per man per day.

The men are hired almost exclusively at Mammoth Hot Springs, where they are required to register and those of the higher grades to take out the necessary civil-service papers.

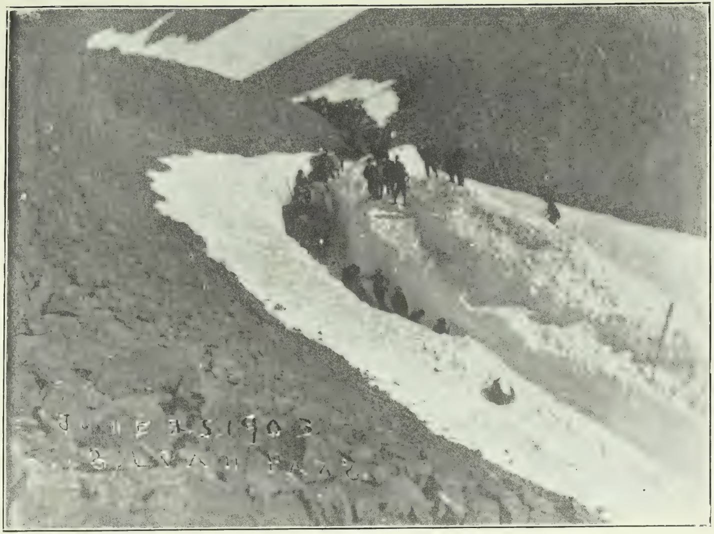
In going to the field the employees are not allowed time in reaching their place of work unless they stay for a period of six weeks, and are not allowed time returning unless they remain to the end of the season. Careful precautions are taken in all directions to guard against unnecessary leaks and waste of public money.

In the matter of payment it is customary to send clerks to the parties in the field as soon after the end of the month as practicable, where rolls are signed and brought to the central office. Here they are computed and compared and the checks drawn, and these are generally delivered by the 15th of the month following that for which they are in payment.

For the purpose of keeping track of the cost of the different portions of the work daily distribution sheets are kept in each camp. These show the amount of expenditure that goes upon each particular piece of work.

Cost.—The present project for the road system contemplates an expenditure of $750,000, with which it is expected to have all the roads

WORKING CAMP.



SHOVELING THROUGH SYLVAN PASS, JUNE 25, 1903.

opened, the earlier roads rebuilt, a good surface provided on the main system, and fully 75 per cent of the system under sprinklers. This work also includes several important structures.

There will still remain much work to be done, but none of it of the same urgency as that now being done. Ultimately the roads will all be widened to 25 or 30 feet and macadamized to the full width. The bridges will all be of steel or masonry, the culverts of pipe, and everything else on the same basis. This will cost a great deal of money and take a great deal of time. On the scale of the roads in the Maritime Alps it will cost not less than $10,000 per mile. This thorough work, however, was wholly impossible at first, and is even yet so to a large extent. It was necessary in the first place to give access to the objects of interest in the shortest possible time, and the first old wagon trails did not cost more than $500 per mile. Between these two limits the character of the work rests, gravitating continually from the smaller figure to the larger. For this reason it has never been considered necessary to go into elaborate surveys and estimates, but the money has been applied to the work most needed, and the quality of the work has depended upon the funds at the time available. The whole system is being progressively developed, and every new contribution made by Congress is applied where most needed, and all tends toward the final result. Whether the road costs one or five or ten thousand dollars a mile depends upon the degree of approach to an ultimately perfect road. In some places the final result has been nearly accomplished; in others it is but just begun, and many years will elapse before its final completion will be witnessed.

MAINTENANCE AND REPAIR.

Opening roads in spring.—The problem of maintenance of the park roads is in every respect a difficult one. The pressure for travel which begins early in the spring makes it necessary to open the roads before the condition of the ground after the melting of the snow is such as to justify travel. Heavy loads of hotel supplies must of necessity pass over the roads as early as the middle of May, while they are still covered with snow and are everywhere soft and wet. This traffic cuts the roads up until they become in many places almost impassable. About the 1st of June the regular coaches begin to run, and it is a common experience that travel for the first two or three weeks of the tourist season is difficult on account of the mud. This early traffic breaks up the hard condition of the roadbed and leaves it in a bad shape to resist the contrary action of dry weather which follows immediately upon the cessation of the spring rains. There is, of course, only one way to meet this diffiulty, and that is to provide a rock bed for the roads sufficiently deep and strong to resist the action of the early wet weather.

The general practice in opening up the roads has been to put numerous parties in the field from two to three weeks before the tourist season opens, shoveling through the drifts, draining off the surface water, and doing whatever is possible to get the roads into a condition where they can carry the heavy loads to which they are subjected. Later, as soon as the snow question is out of the way, road machines are put upon the roads to smooth up the surface. These machines are very effective and are an indispensable part of the road plant. Even

during the dusty season they produce good results by filling up the ruts which the wheels cut into the dry surface.

Sprinkling.—The dust question is the most serious of all, everything considered, in connection with the maintenance of the roads. There is no doubt that dry weather is a greater drawback and a greater source of damage than wet weather. Moisture is an indispensable condition to the cohesion of the soil, and as soon as it disappears the surface of the road begins to disintegrate. In like manner the wood of the culverts and bridges shrinks and loses a good deal of the strength which comes from close contact of contiguous parts and goes to pieces rapidly under the action of the wheels. A culvert that will hold in good condition during wet weather fails quickly when dried out. Water is therefore an essential element in the maintenance of the roads, and the great problem in recent years is how to secure it. There is no obvious way to do this except by sprinkling, and consequently a system of sprinkling is being inaugurated. It is now fully believed that in this system, as it is being worked out, the solution of the problem of maintaining the roads will be found.

The present working of the system is as follows: Two sprinklers operate from a single camp 5 miles in opposite directions, going out in the morning and returning in the afternoon, thus sprinkling 10 miles of road twice a day. It would undoubtedly be better to do this sprinkling in the nighttime or in the early or late hours of the day when the water can have an opportunity to soak in before it evaporates, but the question of meals and team feed in camp makes this almost impossible. With each sprinkler there are two men, one driving the team (four horses) and the other following behind the sprinkler with a shovel to throw out the loose stones and do any other temporary work that may be required. Wherever the sprinkler stops to fill the two men unite in doing the necessary work, whether by pumping or by handling the valves for overhead filling.

The two sprinkling outfits comprise four men and four single teams. At the same camp there are also three other laborers and one team whose duty it is to go over the road filling incipient ruts, repairing culverts, and doing whatever other work is necessary. A cook at laborer's wages is kept at the same camp, making eight men in all. Whenever rainy weather comes the sprinkling teams are either laid off or are used in hauling surfacing material. As soon as the rainy spell ceases, and before it is necessary to resume sprinkling, two of the teams are put upon a road-grading machine and sent over the particular district to which the camp pertains. All ruts caused by the wet weather are filled up and the road surface smoothed off.

This system of treating the roads produces very satisfactory results. While it does not entirely lay the dust, it will, if the road is well surfaced, practically do so. Not less in importance is the effect of the water in preventing the disintegration of the road surface and its blowing away in dust.

The sprinkling plant consists of two essential parts—the means of filling and the sprinklers themselves. Although the park abounds in mountain streams, it is found very difficult to get water at the exact places wanted, and there is probably an aggregate distance of not less than 25 miles where it may never be possible to secure it at all. Wherever the situation will permit overhead filling is resorted to; that is, tanks are located at least 15 feet above the road and a 3-inch

pipe is led from them under a sufficient head to give a flow that will fill the sprinkler in from five to ten minutes. The pipes are led from the tanks to the edge of the road, where they terminate in a quick-working valve and about 4 feet of hose. Where overhead filling is not practicable pumping is resorted to. If the supply of water is very small, large tanks are provided, of a capacity equal to and in some instances a half greater than that of the sprinkler, so that the water may accumulate in them during the entire twenty-four hours. Where the supply is ample small boxes are used of 2 or 3 cubic feet capacity in which the end of the pumping hose can be inserted. In some instances pumping direct from streams or pools is resorted to. The necessity of securing filling places at regular intervals has led to the practice of carrying water along the ditches of the roads in many places. This experiment has been very satisfactory, as the presence of running water along the dry roads is in itself a desirable feature.

The sprinkling tanks have a capacity of 750 to 850 gallons, are made in the most approved manner of the best material, and are specially adapted to this particular work. The wheels have tires 6 inches wide, and the front axle is 12 inches shorter than the rear axle, so that the sprinkler acts as a road roller covering a width of 1 foot on each side of the road. As the weight of a loaded sprinkler is about 5 tons, the rolling effect is considerable.

For convenience of pumping a platform is built on the rear of each sprinkler, and on this is placed an Edison diaphragm force pump, with two levers. The capacity of this pump is such that two men can fill the sprinkler, lifting water a distance of 10 feet, in about twenty minutes. Attached to the pump is a 3-inch rubber hose with a strainer on the end, the holes in which are smaller than the holes in the sprinkling sprays, so that any material which might pass through this strainer will escape from the sprays. Under the pump platform is a tool box containing the necessary tools for the repair of the sprinkler.

These outfits are hauled by four horses and are provided with the necessary equipment and also with strong brakes for downhill work. They are arranged so as to be capable of turning in their own length. There are two vertical sprays, each covering a width of 4 feet. Convenient levers are provided so that the driver can control both brake and spray with facility.

The principal drawback in this work is to secure the right kind of help. The opportunities for slighting the work are so complete that it is difficult to insure its being thoroughly done. There is no way in which it can be told whether the men fill the sprinkler to its full capacity except in the appearance of the sprinkled road, and that becomes a doubtful criterion to judge by after a little time has elapsed. The only way to enforce strict work is by a continuous inspection by competent foremen.

Use of oil.—There has been much agitation for the use of oil in laying the dust on the park roads and in otherwise preserving them, and the matter has been thoroughly investigated.

The use of oil on highways began on an extensive scale in 1898 near Los Angeles, Cal. It has since that time grown into a recognized system of road construction and maintenance and is generally adopted throughout that State.

Oil was first used for the specific purpose of laying dust, but it soon became apparent that it was equally useful, if properly handled, in

preserving the roads in wet weather. It was found to form a hard crust, which resisted water well and gave a surface approaching in appearance and utility an asphalt pavement.

Only oils with an asphalt base are thoroughly effective for road uses. The paraffin oils, like most of those from the Pennsylvania fields, do not give good results. The asphalt oils are found in both Texas and California, but particularly in the latter State. For this reason the use of oil on highways has found its highest development in California.

To produce the best results the roadbed should be carefully prepared for the reception of the oil. It should be well graded and crowned for purposes of surface drainage, and also be protected against the infiltration of water beneath in sufficient quantity to soften the foundation.

In order to incorporate the oil well with the soil it is important to harrow up the surface both before and after application. This is ordinarily done with a machine, which also carries the spray for distributing the oil. It is not practicable to let the oil out of ordinary sprays, as with water sprinklers, owing to the difficulty of regulating the flow closely enough under the varying head. It is made to flow out of the main tank into a small auxiliary tank hauled in rear, from which it flows onto the roads. Immediately in front and rear of the discharge openings are sets of inclined harrow teeth, which scratch up the ground and hasten the incorporation of the oil. This auxiliary device is called a distributer.

It facilitates the incorporation of the oil if it can be put on hot, but special apparatus is required for this purpose, and the cost is considerably greater than when it is put on cold.

When the road surface is too hard to harrow up effectively, a coating of sand should be applied to take up the oil.

The quality of oil required varies with the soil, travel, and width of road. Subsequent applications require less oil than the first. One authority gives for the first sprinkling of a 16-foot roadway 250 to 400 barrels of 42 gallons each per mile. For the park work 130 barrels have been estimated as meeting the necessary requirements. No attempt would be made to sprinkle wider than 10 feet.

While the use of oil on the roads of California is a distinct success, it was found impracticable, on account of the cost, to use it in the park. The following figures show this conclusively: Cost of oil in Bakersfield, Cal., 25 cents per barrel; freight, Bakersfield to Portland (S. P. R. R. nearly all free), 8 cents per 100 pounds; freight, Portland to Gardiner (N. P. R. R. nearly all 50 per cent), 65 cents per 100 pounds; weight of barrel of oil, 325 pounds; freight per barrel, Bakersfield to Gardiner, \$2.37; contract price for freight hauling in park, \$1.47 per 100 pounds per 100 miles; average haul, 35 miles; cost per barrel, \$1.67; cost of application not less than 25 cents per barrel. Total, \$4.54.

Assume first application to require 130 barrels per mile, the cost, at the above estimate, would be \$590.20.

This estimate does not include the cost of plant, which would be not less than \$3,000.

This method of treating roads is covered by a patent, and the royalty charge would be \$15 per mile per year.

If the oil were to be used only where it is impracticable to get water

for sprinkling, say 25 miles, the cost of the plant would add $150 per mile to the first year's sprinkling.

It is assumed that one sprinkling per season would be sufficient, and that the amount required would not be as great in the second and third seasons as in the first—say 130 barrels first season, 80 barrels second season, and 40 barrels in the third and subsequent seasons.

Charging the plant to the first season would give the following costs:

First season	per mile	$755.20
Second season	do	378.20
Third season	do	196.60

Under the most favorable circumstances, therefore, the annual cost per mile will be not less than $200 after the system is established. This estimate contains the following uncertainties: One sprinkling per season might prove insufficient. In this cold climate the oil might not incorporate well, and in that case would prove an intolerable annoyance. The free freight rate over the Southern Pacific might not hold, for there is a contention on the part of that road that the Government right to free haul applies only to munitions of war. This would materially increase the cost, which is already practically prohibitory.

On the whole, it does not seem advisable to try the experiment until a supply of suitable oil is discovered near the park.

Wide tires.—As a means of maintaining the roads in good condition, a regulation has recently been secured requiring the use of wide tires in all heavy freight hauling. The advantages of wide tires are thoroughly established, but there has been a deep-set local prejudice in the country around the park to their adoption. This arose mainly from the desire to avoid the cost of change of equipment, but to some extent also from a belief that they would draw harder than narrow tires. Arguments of various sorts were used to oppose the change, nearly all of them fallacious and easily disproved, but still sufficient to convince an unwilling public. However, the regulation has practically gone into force, and the result has been a general conviction on the part of everyone of its great advantage, and the prejudice against it will probably disappear in a short time.

It would be difficult to name any one regulation relating to travel upon the roads which is of more importance than that of the use of wide tires in the hauling of heavy freight. There are only two conditions of the roads in which they are at a disadvantage as compared with narrow tires. Where roads have been barely opened and are in a condition of mere wagon trails, and are full of stones and roots, a narrow tire has the advantage, because its smaller width avoids to a greater extent the roots and stones and picks its way more easily along the surface of the ground. Again, in the winter season, when there is ice on the ground, the wide tire naturally has a weaker hold than a narrow tire in descending steep grades.

The wide tire gives an easier draft in all conditions of well-graded roads except one. Where mud is so soft or sand so deep and fine that either will run over the felloe if it sinks deep enough more material will naturally cling to a wide tire than to a narrow one. In thick mud or bog or heavy sand or on turf the wide tire gives the lighter draft. On a pavement or thoroughly hard road surface there is no appreciable difference between the two.

But while the advantage of draft is on the side of the wide tire, the great argument in its favor is its effect upon the roads. That it saves

them as compared with the narrow tire, whatever the condition of the road, there is no question. Even in dusty weather they compact the surface and lessen the annoyance from this source. Bicyclists have assured the writer that they have been of very great advantage to wheeling by reason of their effect as road rollers.

Wagon tracks.—A condition affecting the appearance of public highways which is everywhere noticed is the irregular and sinuous course of the wagon tracks. No matter how carefully a road may be aligned, the teams are liable to take an irregular course over it, first on one side and then on the other. As horses always follow the beaten track, and as drivers rarely take sufficient interest in the matter to straighten out these kinks, the road soon takes on this irregular appearance, which greatly detracts from its beauty. In the park work the sprinkling outfits are instructed to place obstructions wherever these irregularities develop, so as to force travel into regular lines, and in this way the difficulty is largely overcome. It may be noted in this connection that curved roads have a great advantage over straight roads, because in rounding a curve traffic naturally falls into a regular line.

Chipmunks.—A singular condition improving the appearance of the roads is the work of chipmunks in carrying away offal from the surface. This animal is a very diminutive creature, much smaller than in the Eastern States, but it abounds in great numbers, and is seen everywhere industriously at work.

TRAFFIC OVER THE PARK ROADS.

Freight traffic.—In travel over the park roads the character of vehicles depends upon the various uses to which they are put. While the roads are primarily for tourist travel, they are at present largely used for freight, owing to the necessity of hauling construction material for the hotels, for the building of the roads, and supplies for the use of the military force and the public during the tourist season. This freight traffic is at present exceedingly heavy. It will materially diminish in the future, after the work on the roads and the hotels is completed.

Freight is generally hauled in loads of two wagons, the rear one of which is called a trailer and is fastened to the lead wagon by a short, heavy tongue. At least four horses are always used, frequently six. These are generally handled by a driver from a seat on the lead wagon, but sometimes by a man riding the near wheeler and managing the lead teams with a jerk line. For holding back the wagons when a team stops to rest in going up the hills, a block is generally drawn along behind so that it will trail close to the wheel. In many cases, however, one of the men accompanying the load walks behind the outfit and blocks the wheel with stones. With the customary indifference on the part of these people to the condition of the roads, they generally leave these stones where they place them, and they remain there until the road crews can throw them out.

Competition in freight contracts compels the use of unreasonably heavy loads in order to bring the cost of the work within a living rate. Single wagons occasionally carry 12,000 pounds, and double wagons as much as 18,000 pounds. These loads are undoubtedly heavier than they ought to be and are a great strain upon the roads, particularly in the spring or the late fall. They are the chief source of damage to

which the roads are subjected and not infrequently cut them all to pieces during prolonged spells of wet weather. It will probably be necessary to ask for some regulation limiting the tonnage of these loads.[a]

The freight traffic in the park, while it is something necessary, is one of the principal drawbacks to the pleasure of travel. The outfits are generally so loaded that it is difficult for them to turn out, and their slow and unwieldy character causes delay in getting past them; moreover, the drivers being seated in front of the load, which is often so high as to prevent their seeing back, do not know, and sometimes do not care, what may be happening behind them, and there is often much delay in passing by light vehicles coming up in the rear.

Empty outfits returning generally take off the lead team, place the harness in the wagons, and tie the horses behind. It often happens, in attempting to pass such an outfit, that these horses are startled and try to get past their own wagon, thus spreading out and effectually blocking the road.

To diminish as far as possible the injury to the main roads and the annoyance to passenger traffic arising from freight hauling, it is contemplated to use the old abandoned roads as far as possible for this purpose. They are so used already in several places, particularly by returning empties, and a small amount of work will make it possible to utilize probably 20 miles of these roads.

Passenger traffic.—For the hauling of passengers, the principal tourist companies use Concord coaches. These are hauled by 4 horses on the main system of the park, and carry from 8 to 14 passengers each. Between Gardiner Station and Mammoth Hot Springs much larger couches are employed, hauled by 6 horses and capable of carrying as many as 30 passengers. For the handling of such heavy outfits, however, exceptionally good and safe roads are necessary, as the slightest accident of any kind might produce serious results. The speed of the coaches throughout the park averages 5 miles per hour. These larger conveyances are supplemented by surreys and lighter outfits.

Camping parties.—The regular camping companies use ordinary spring wagons to a large extent. Private camping parties that visit the park in large numbers from the surrounding country, mainly from the farms and ranches, use vehicles of all sorts and descriptions. It is

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[a] *Table showing reasonable limit of loads for different widths of tire and loads actually hauled.*

Assume as allowable weight to July 1, 450 pounds per inch width of tire.
Assume as allowable weight after July 1, 550 pounds per inch width of tire.

	Allowable loads, including weight of wagon.		Actual loads.	
	Before July 1.	After July 1.		
	Pounds.	*Pounds.*		*Pounds.*
1-inch tire	1,800	2,200	Light single rig	750
1½-inch tire	2,700	3,300	Surrey	1,200
2-inch tire	3,600	4,400	Coach (small)	4,100
			Freight	12,000
2½-inch tire	4,500	5,500	Coach, 6-horse	8,750
3-inch tire	5,400	6,600	None in use.	
4-inch tire	7,200	8,800	Freight	12,000
5-inch tire	9,000	11,000	None in use.	
6-inch tire	10,800	13,200	Sprinklers (750 gallons)	10,370

not uncommon to find a miniature sleeping-car outfit mounted on a single wagon and covered with canvas, with folding beds fastened up on the sides in daytime and let down for use at night; with a cook stove in one end and lockers for cooking utensils and other things under the seats. Some of these outfits are of such width as to be a serious menace to travel. As a general thing, campers use the ordinary canvas-covered heavy wagon.

In many instances ranchers, after having closed their spring work, take their families, with one or two cows, a few chickens, and a limited assortment of produce, and spend a good part of the summer in the park, grazing their stock and living at comparatively no expense. They are not permitted, however, to camp for any great length of time in a single place.

Automobiles.—There has been much agitation for the use of automobiles in the park. There can be no question of the great advantage of this kind of conveyance if it were practicable to put them into use. The greatest source of dust, which is the chief annoyance to travel, is from the action of the horses' hoofs, and if this could be eliminated the dust question would be very much improved. But there is one obstacle which will probably prove insuperable to the adoption of this vehicle, and that is the danger of frightening teams. There will always be a large amount of team travel in the park, and the horses of this country, unlike those of the city, do not readily become used to vehicles of the above description. It is even found necessary to require bicyclists to dismount whenever meeting teams in order to prevent accidents.

Electric lines.—There have been numerous attempts to introduce electric lines in the park. In some respects these would serve an important purpose, but the sentiment of the country is against them, and it is considered desirable to exclude them altogether and permit only coach travel upon the park roads.

The difficulty of building an electric line would be considerable. It has been proposed to lay the track upon the park highways, but this would not be possible, as they will always be used to a large extent by teams, no matter if an electric line were built. As the roads now occupy all the advantageous routes it would be a matter of great difficulty and expense to build a line outside of them. However, these difficulties could probably be overcome if it were not for the sentimental objection to permitting anything of the kind in the park. In fact if the money which an electric line would cost could be used in improving the condition of the roads the discomforts of travel would be so far removed as to make an electric line wholly undesirable. A great majority of the traveling public prefer, on coming to the park, to get away from the innovations of modern travel and enjoy the open-air coach rides of these mountains.

The argument of reduced cost of travel, if an electric line were built, is a visionary one. The enormous first cost of such a line and the cost of operation would require a charge quite as great as the present if the line were to pay. Finally, such a line could never accommodate the public as a carriage line would. It would have to run on a more rigid schedule. It could not make side trips, or run at hours to satisfy special parties, and it would lack so much of the elasticity of the present system that horse vehicles would still have to be used extensively to supplement it.

NEAR VIEW OF ENTRANCE GATE.

SPECIAL WORKS.

Among the works of special interest, from a technical point of view, the following will be briefly described: The entrance gate at Gardiner, Mont.; the Golden Gate Viaduct; the Melan Arch Bridge over the Yellowstone at the Grand Canyon; the concrete dam, aqueduct, and fountain at Mammoth Hot Springs.

Entrance gate at Gardiner.—The importance of the northern entrance to the park is such that it was considered desirable to erect an entrance gate at that point. The Northern Pacific Railroad touches the park boundary at the same point, and the railroad company proposed, in the erection of their station, to combine it with the Government work in a manner to give an effective approach for tourists coming from that direction. The conformation of the ground lent itself admirably to this purpose. The railroad was made to terminate in a loop practially tangent to the boundary of the park, and the Government road likewise terminates in a loop tangent to the boundary at the same point. Between the two the station is located, with a long train platform on one side and a coach platform on the other. The space within the loop of the Government highway has been converted into a small park, planted with shrubbery, and ornamented with a small pond, both of which are sustained by water brought from the Gardiner River.

The station is a unique and interesting structure, built after the design of Mr. R. C. Reamer, an architect of great originality, and particularly skillful in adapting his work to natural surroundings.

The loop and park are in a depression in the hills, around the sides of which the road rises from the level of the station platform to a height of about 30 feet at the neck of the loop. Across this neck the entrance gate, in the form of a large stone arch, has been built.

The gate consists of two square stone towers, with a batter of 1 in 30, the bottom dimensions being 12 feet 8 inches square. The clear space between the towers at the ground is 19 feet 8 inches. It is closed over by an arch, the crown of which is 30 feet above the ground. This arch curtain is 5 feet thick, and is built up to the same height as the towers. The entire structure is 50 feet high, and is capped with a concrete roof, roughly shingled with the chippings from the cut stone used in the arch.

The character of the masonry is entirely original. It consists of columnar basalt, taken from a quarry near by, in approximately hexagonal prisms. These have been used just as found, with the least possible dressing, retaining their natural weather-worn condition. The points of the prisms project beyond the plane of the face and give to the whole structure a novel appearance as a masonry work. The two base courses are roughly cut, as, of course, are the stones in both the small and the large arch rings. The cutting of this stone was a very difficult matter, owing to the extremely hard quality of the rock.

The side of the structure which faces the station is ornamented with three tablets. The largest is 3 feet 10 inches by 20 feet 8 inches, and bears the inscription, "For the benefit and enjoyment of the people"—an extract from the act creating the park. The smaller tablet on the left tower is inscribed, "Yellowstone National Park;" that on the right, "Created by act of Congress March 1, 1872." These tablets were molded entirely of concrete. The forms for the letters were manufactured by the Stillwater Manufacturing Company, of Stillwater,

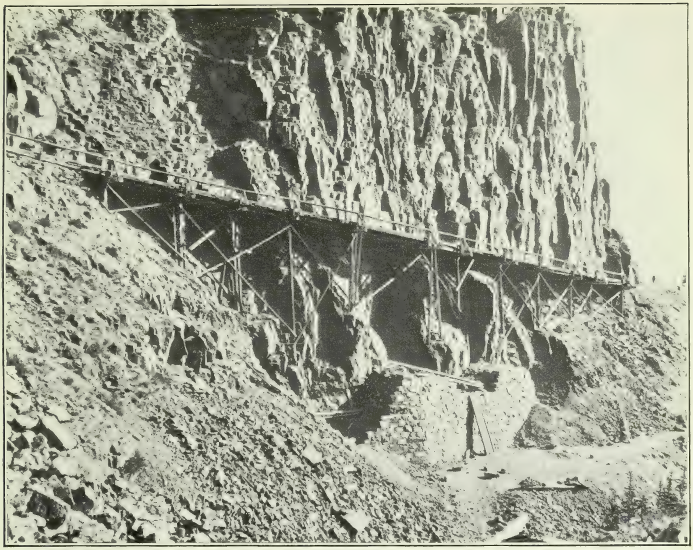
Minn., and were cut out in reverse with great accuracy. They were made so as to give a depressed letter in the concrete, and with a triangular cross section, so as to be easily removed after the concrete was set. They were nailed upon a suitable frame, which was placed in position to close a recess left for the purpose in the masonry. For the larger tablet this space was 18 inches deep—that is, 18 inches from the face back into the wall.

The concrete used was in the proportions 1, 2, and 4. A mortar facing was put in at the same time, sufficiently thick to cover the letters. The concrete rested directly upon the masonry below it. As soon as the space was filled, and before the concrete had set, the course of stones above was laid upon it, so that their weight pressed into the block, making a perfect bed. The forming was held in position by means of rods previously laid in the walls.

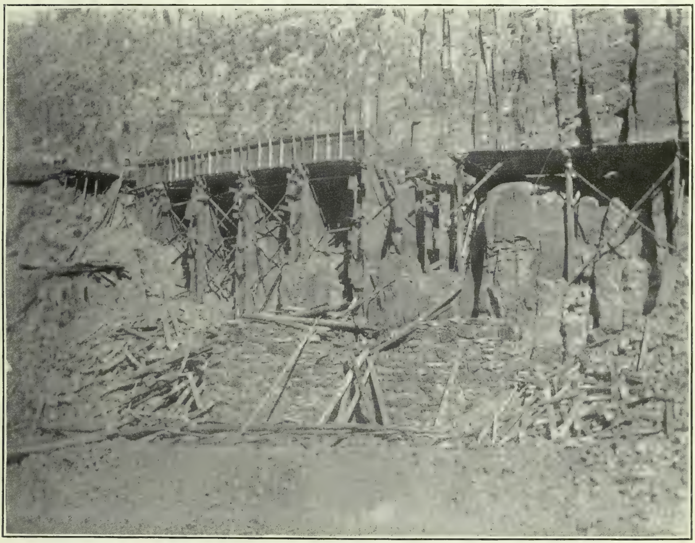
Extending from the tower of the arch in both directions for a distance of about 30 feet are two wing walls 12 feet high, terminating in square towers about 14 feet high. From these towers walls 8 feet high extend along each branch of the loop to the park boundary.

Golden Gate Viaduct.—The Golden Gate Viaduct is a concrete structure designed to carry the road around the face of a nearly vertical cliff. The question of choice of material turned both upon the general appearance of the structure and the necessity of making quicker work than the condition of the steel market would permit if steel were used. To have built a steel structure would have required accurate surveys and close examination of the foundations, including borings, which, together with the great difficulty of securing prompt deliveries of steel, would have made it practically impossible to erect the work during the season in which it was felt it should be erected. With concrete, on the other hand, surveys of the foundation could be omitted, because it was only a question of using a little more or less concrete, according as it might be found necessary to carry the piers more or less deep into the rock. It was much easier, moreover, to get prompt cement deliveries than steel. Finally, it was believed that a series of arches built against the side of the cliff and fitted to the natural face of the rock would produce a more pleasing effect than a steel structure. For these reasons concrete was adopted.

The viaduct consists of eleven arches resting on two abutments and ten piers, the whole being on an 8 per cent grade and on a 10° curve. The radius of the outside of the parapet wall is 573 feet. The length on center line is 200 feet, and the abutment wing walls extend 12 feet farther at each end. The arches are terminated at their inner extremities by the irregular and nearly perpendicular face of the cliff, leaving a roadway averaging about 18 feet in width. The piers are spaced 18 feet center to center on the outside and converge 6½ inches in 18 feet. They are 3 feet thick. The arches are 18 inches thick on the pier, 12 inches at the crown, and have 24 inches rise. Piers and arches are built of Atlas Portland cement concrete, the former in proportion of 1, 2, and 4, and the latter in proportion of 1, 2, and 3. In the crown of each arch is embedded a piece of wire netting, 7 by 15 feet, made of No. 8 B. W. G. wire, meshes 2½ by 5 inches, the long dimension of mesh and short dimension of the piece of netting being parallel to center line of bridge. The piers rest upon horizontal surfaces stepped into the solid rock, and where these footings are separated by surfaces inclined much from the vertical anchor bolts were embedded in them.

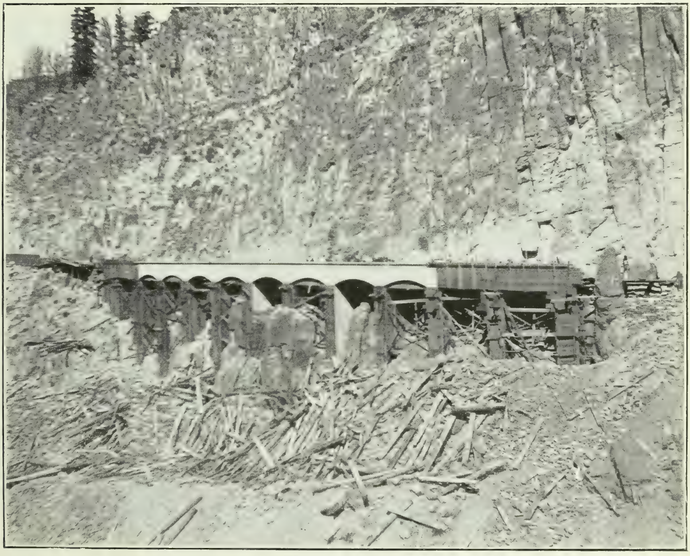


OLD GOLDEN GATE VIADUCT.



ERECTION OF FORMING FOR GOLDEN GATE VIADUCT.

CONCRETING GOLDEN GATE VIADUCT.



REMOVAL OF FORMING FROM GOLDEN GATE VIADUCT.

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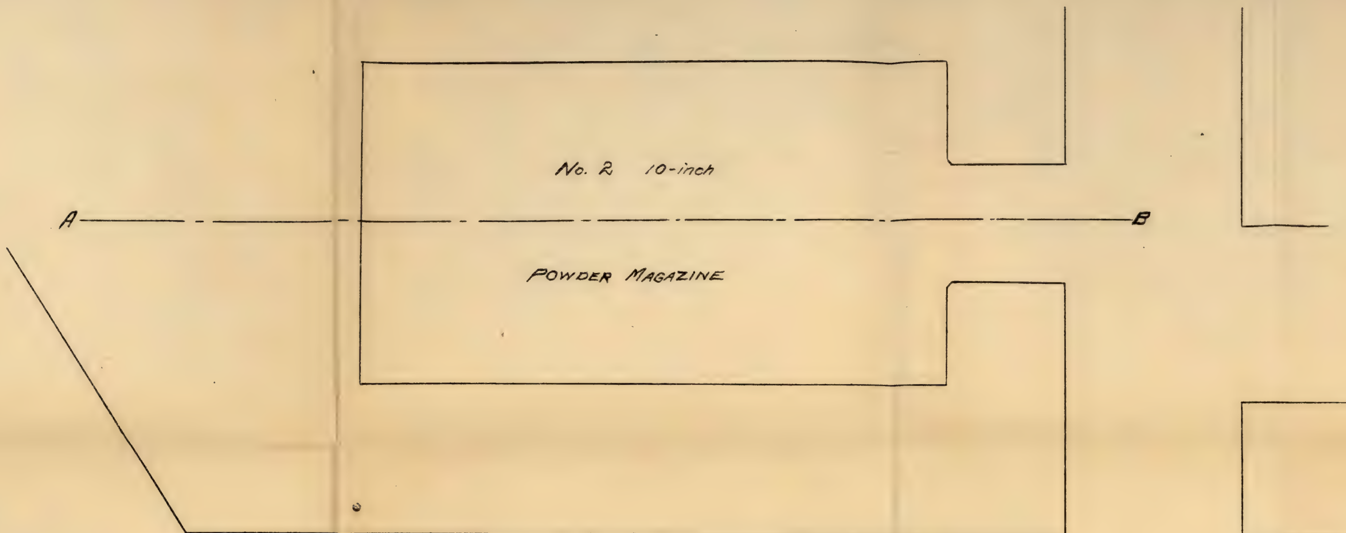
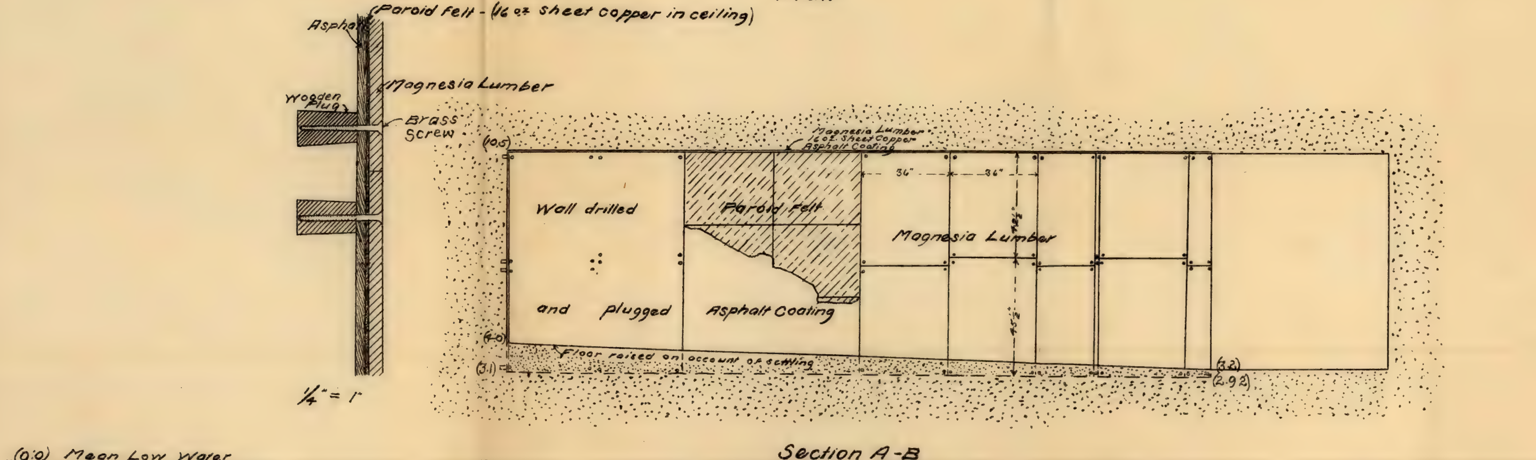


Plan



Section A-B

Method of Lining

Nº 2 10-inch Powder Magazine, Ft. St. Philip, La.,

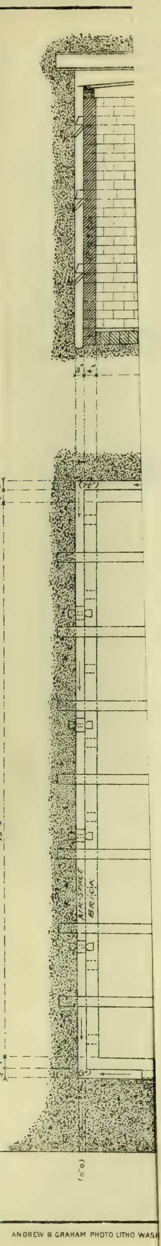
with Magnesia Lumber to prevent condensation

Drawn under the direction of Lieut. Col. H. M. Adams, Corps of Engineers, U. S. A.

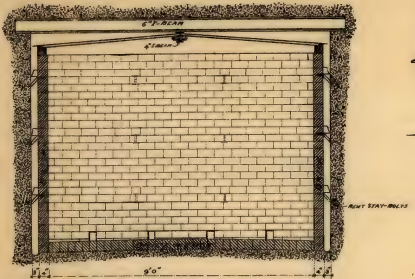
by J. G. Ross, Junior Engineer

June 9, 1903

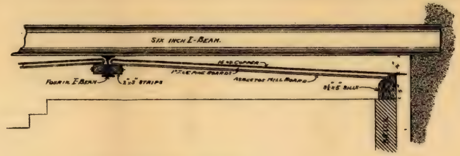
Scale: 1/4 inch = 1 Foot.



ANDREW B GRAHAM PHOTO LITHO WASH

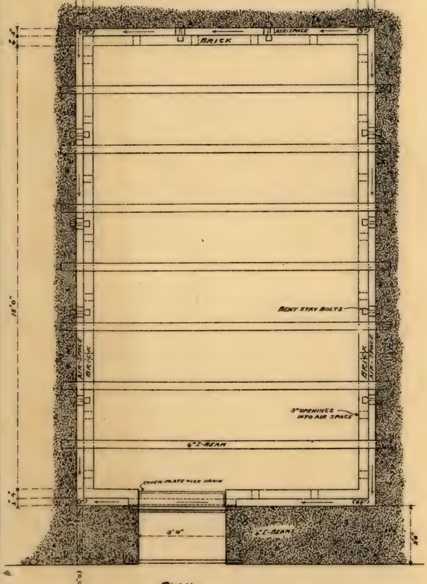


SECTION.



DETAIL OF ROOF CONSTRUCTION

SCALE ½ IN = 1 FT.



PLAN.

SCALE ¼ in = 1 FT.

WATERPROOF LINING
FOR FORTIFICATIONS DEFENDING HARBOR AT MOBILE ALA

U. S. Engineer Office, Mobile, Ala.
August 28th, 1903.

To accompany letter of this date,
to the Chief of Engineers, U.S. Army.

W. E. Craighill
Captain, Corps of Engineers U. S. Army.

Work was begun at the west or highest end of the bridge. The west abutment and the piers were all concreted before the arches were begun, and these were then put in alternately. Each arch and corresponding parapet wall were put in at the same time as one piece, the section being limited by the vertical planes upon the radial center line of each pier. The joints thus formed afford the necessary expansion cracks, the opening and closing of which could be observed at the completion of the bridge. Railroad iron in 4-foot lengths was embedded in arch and parapet wall, four pieces to each arch, to strengthen the connection between the two. The valleys between each arch inclined to the inner edge of roadway, where 2-inch iron pipes are inserted for weep holes. In addition to the heavy abutment and wing wall at the lower or eastern end of the bridge, the irregularities of the cliff at the inner edge of the roadway, into which the arches are keyed, afford an additional precaution against the sliding of the arches upon the piers downhill by expansion and contraction. Each section of parapet wall was keyed into the adjoining section by a vertical 2 by 6 inch tongue and groove extending from the top of the pier to the under side of the rail of wall, so that it does not show in the finished structure.

The execution of this work was one of extraordinary difficulty. This arose first from the conformation of the canyon and its influence upon the winds, which prevailed during the entire season. The canyon is practically the small end of a funnel, which gathers up the wind on the plateau above and conveys it through to the lower country. The wind was high nearly every day during the work. At times it attained the force of a gale with sufficient power to pick up stones one-half inch in diameter. When it came to mixing the concrete it was found almost impossible to conduct the work during the middle of the day. The dust and cement filled the eyes and lungs of the workmen in spite of goggles and kerchiefs. On this account men kept constantly quitting, notwithstanding increased pay for concrete work, and their places had to be filled with new and inexperienced men. Of the original force few were working at its completion, although a nearly uniform number was maintained by constant recruiting. The number of men employed during the concreting was 91, and the actual time spent was 122 hours on 19 different days. Only one accident occurred during the work, and that was by a man being actually blown from the forming onto the rocks below.

The lack of storage space was another serious handicap, as everything had to be handled in the narrow space of the roadway above and below the viaduct.

Another difficulty in connection with this work was the necessity of rushing it to the greatest possible extent. Tourist traffic had to be turned into a side road, where the steep grades and excessive dust involved both danger and discomfort. Consequently the work was pushed with extraordinary speed, and the road was closed to travel only about four weeks. During this time the old bridge was taken down, the forming put up, and the concreting completed. The total amount of concrete put in was 545 yards.

For the concrete a natural mixture of gravel and sand was used, taken from a quarry about half a mile distant. There was a small percentage of loam in this gravel, but it was considered sufficiently clean to justify avoiding the heavy expense of washing, and it was put

in the structure as found in a state of nature. Of the wisdom of this course time alone can tell, although up to the present date there is no indication of any weakness arising from this source.[a] The structure was put in during the season of 1900, and was used during the latter part of that season and the three seasons since.

Among the defects developed in this structure, which could be corrected if it were to be built anew, the only one of any importance was the failure to provide effectively against seepage. The concrete was not of particularly close character, and it was found that the surface water of the road drained through it with facility. The waters streaking down the piers caused a white deposit, which disfigured the structure to a considerable extent. That, however, was remedied by going over it with a cement wash. Some measures were taken to close the joints in the parapet wall by means of lead, but they were only partially successful. The compacting of the roadway has largely prevented the infiltration of water from above, and the condition as to leakage materially improves as time goes on.

If the work were to be done anew, the following measures would be taken to prevent the above-noted defect: The joints would be made water-tight by the use of strips of sheet lead, which will be noted below in detail in the description of the concrete dam built at Mammoth Hot Springs. The upper surface of the arches would be given a coating of some waterproof wash like the alum-lye wash used on Government fortifications. In this way the leakage would probably be nearly all prevented.

In connection with the erection of the Golden Gate Viaduct occurred the removal of the large rock which has given the name to the structure. This rock was a natural tower about 15 feet high and weighed over 23 tons. It originally stood within about 8 feet of the cliff, and the roadway passed between the two. Its position did not fit with the grade of the new structure, and its proximity to the cliff made the road altogether too narrow. For this reason it was decided to break it off

[a] Some very interesting experiments have recently been made by Prof. C. E. Sherman, of the Ohio State University, who, as United States assistant engineer, had immediate charge of the work on the viaduct, the purpose of the experiments being to determine the effect of small percentages of loam or clay in concrete mixtures. Following are the conditions under which the experiments were conducted:

All mixtures are 1 cement, 3 sand, and percentages of clay or loam to sand.

Both cements were bought in open market and tested well neat, the Lehigh showing considerably stronger.

Three kinds of sand were used—standard crushed quartz as per American Society of Civil Engineers specifications; lake sand from Lake Erie, 40 per cent voids, and all passed a No. 30 sieve; bank sand from the Mock bank, south of the city of Columbus, Ohio, a large source for local supply, weight 102 pounds per cubic foot, all passed a No. 12 sieve.

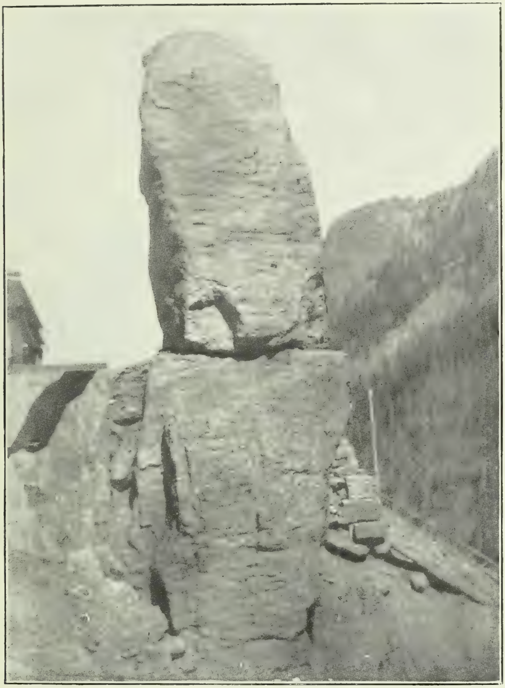
The clay used was Mayfield ball clay (Mayfield, Ky.), ground fine. It had no hydraulic properties.

The loam was common field loam (brown soil) with a considerable percentage of organic matter. This was dried and ground fine before using. It was also tested for hydraulic properties and found to have none.

All briquettes were allowed to set in moist air 48 hours, then immersed in water until broken.

Briquettes were broken at 7 days, and at 1, 2, 3, 6, 9, and 12 months, respectively.

The tests were carefully conducted under skilled supervision. The net result was that clay or loam in percentages up to 15 give a material increase to the strength of the mortar. It is difficult to accept results so contrary to received theories, but there is no flaw discoverable in the tests. The great benefit of such a result, if definitely established, will be to eliminate the necessity, and often the great expense, of washing sand which has only a small percentage of clay or loam in it.



REMOVAL OF GOLDEN GATE ROCK.

REMOVAL OF GOLDEN GATE ROCK.

REMOVAL OF GOLDEN GATE ROCK.

and move it out so as to give a sufficient width of roadway and instal it upon an artificial foundation. A natural seam was found, which simplified the matter of breaking the rock, and it was raised with jackscrews and moved on rollers to its new position. Here it was set up on a concrete pillar 3 feet square, and the whole was surrounded by rough stones, which effectively conceal the artificial foundation. To all appearances the rock stands in its natural place as it did before its removal. The cost of removal was slight. Mr. C. E. Sherman, United States assistant engineer, had immediate charge of the engineering details, and Mr. Robert Walker, United States overseer, of the construction.

Steel-concrete arch bridge over the Yellowstone.—Ever since the park was opened for travel visitors have been confined to the left bank of the Grand Canyon of the Yellowstone, owing to the absence of any means of crossing the river. A bridge has been in contemplation for many years, but lack of funds has hitherto prevented its construction. This portion of the river being one of great scenic beauty, it was desired to put in a structure appropriate to the situation; and as such a structure would involve heavy cost, it has never been possible until recently to build one. The design finally adopted was that of a steel-concrete arch.

The most feasible bridge site was at the brink of the upper fall of the Yellowstone, where the river narrows to a width of 50 feet; but it was generally considered by visitors that it would be undesirable to place an artificial structure in that situation, and therefore a site was chosen at the head of the rapids, about a half mile above the upper falls. This site is an excellent one, except that the span (120 feet) is much greater than at the head of the falls. Two points of rock jut out into the river, fitting in well with the road on the left bank and giving a good approach on the opposite bank. The rock is volcanic rhyolite and not of very satisfactory quality for work of any kind; still, from the fact that it has resisted for an indefinite geological period the action of the river, it must have considerable stability. In any case the situation was one that had to be accepted, and the bridge has been founded upon these two jutting points of rock.

The span of the bridge, as above stated, is 120 feet between the ends of the steel arch girders and 160 feet between the ends of the bridge. The rise in the steel girders is 15 feet. The surface of the bridge is given an arch form, the center being 2 feet 6 inches above the ends. This was done in order to avoid the necessity of going too far down with the spring lines of the arch and at the same time not to raise the approaches above the level of the established highway. The effect of this rise in the center of the bridge is pleasing to the eye. The entire width of the structure is 18 feet 6 inches and the width of the roadway 14 feet 6 inches. The concrete railing is 30 inches high. The height of the bridge floor above low water is 43 feet.

The steel work of the bridge consists of ten arch girders, each composed of four angles united by a lattice work. The angles themselves contain the necessary section of steel as computed from the strains to which the bridge will be subjected. It is believed that the lattice girder is better for work of this kind than either a solid beam or two flat bars placed one above the other. In the first place, the necessary section of steel can be had as well in one case as the other, while the distance apart of the two sets of angles can be so adjusted as to meet

the strains in the best possible way. The lattice union causes both flanges to act together. Finally, the open lattice work permits the concrete to be made in a continuous mass through the girder instead of being separated as it would be by a solid web. The dimensions of the angles are ½ by 2½ by 3 inches. The depth of the girder varies from 12 inches at the center to 22½ inches at the ends. The concrete arch ring is 24 inches thick at the crown and 48 inches at the spring line. The center line of the girders coincides closely with the center line of the arch ring and both with the center line of pressure due to the weight of the structure. The girders are united laterally at intervals of 12 feet by cross bars of steel bolted to the flanges.

The filling of the spandrels and approaches was made of concrete instead of earth. Both Lehigh and Atlas cements were used, the former in the 1, 4, and 9 mixture for the filling, and the latter in the 1, 2, and 4 mixture for the arch ring, facings, and road surface. The 1, 2, and 4 concrete was made of broken rock and washed sand; the 1, 4, and 9 mixture of natural unwashed gravel. A large proportion of bowlders (about 200 cubic yards) was used in the filling. The arch ring and all the filling from one continuous mass. The total volume within the forming was a trifle less than 900 cubic yards.

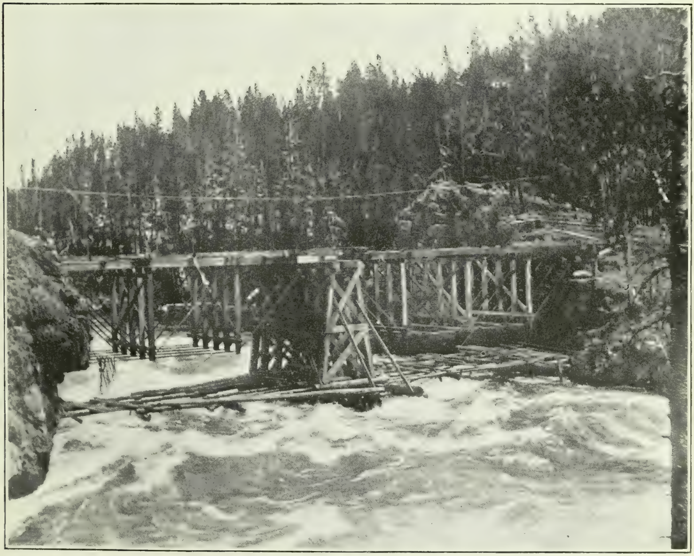
A solid concrete construction being decided upon, without earth filling in any part of bridge or approaches, it was further decided to make the structure act as a solid monolithic mass, without any provision for contraction or expansion. It was evident that the greatest strain tending to crack the concrete would come over the spring line where the arch proper joins the approaches. To resist this as far as possible steel rods were embedded in the concrete 2 feet below the surface of the bridge parallel to its axis, extending from the ends of the abutments nearly to the center of the bridge. The result of this expedient will be referred to further on.

There is a narrow walk on each side of the bridge, provided with an iron guard rail to prevent injury from the wheels of vehicles. The railing of the bridge is made of concrete cast around a steel channel, which is itself supported by steel bars extending down into the body of the bridge. These bars are inclosed in the concrete of the balustrade.

In the construction of the bridge an important difficulty, and perhaps the greatest of all, was the building of the false work and the necessary forming. The false work had to be founded in one of the most violent rapids of the river and was a work of no small risk. The handling of the material was accomplished by means of a steel cable 1¼ inch diameter. No especial contrivance was used for transferring the material, reliance being placed upon an ordinary pulley.

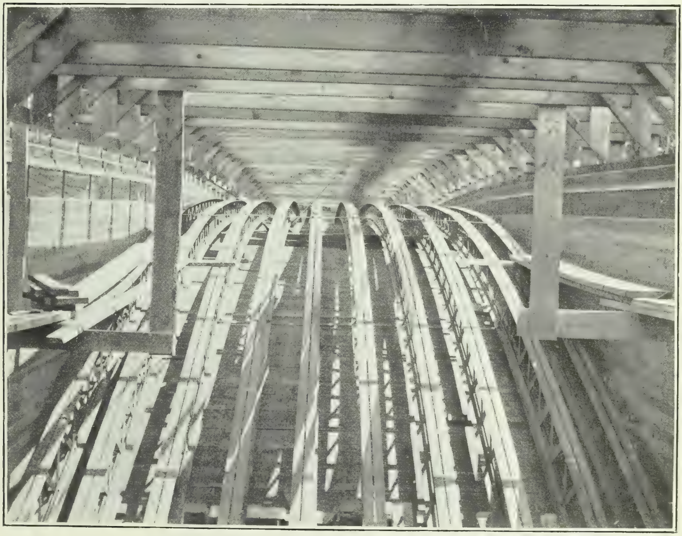
The false work was founded upon two abutments and one pier. The pier consisted of a large crib made of green timber sunk in as close contact with the bottom of the river as possible and filled with rock. It rested around a large submerged ledge of rock, which answered the purpose of an excellent anchorage, as it would be impossible for the crib to slip past it. After the crib was built above water and before much stone was put inside vertical posts to carry a part of the weight of the structure were placed within the crib in contact with the rock bottom of the river. The weight did not, therefore, rest entirely upon the crib, but in part upon these posts. After the posts were set up and secured in position the rock filling of the crib was placed. The false-work abutments at the two sides of the river were placed without difficulty, as the water at those points was shoal and the current not

BRIDGE SITE OVER THE YELLOWSTONE RIVER, LOOKING UPSTREAM.



FALSE WORK FOR SUPPORT OF FORMING.

COMPLETED FORMING FOR BRIDGE.



INTERIOR VIEW OF FORMING JUST BEFORE CONCRETING.

RUNWAY ON BRIDGE FOR CONCRETING.

PARTIAL VIEW OF GROUNDS DURING CONCRETING.

MIXING CONCRETE.

BRIDGE COMPLETE—SIDE VIEW.

BRIDGE COMPLETE—OBLIQUE VIEW.

BRIDGE COMPLETE—END VIEW.

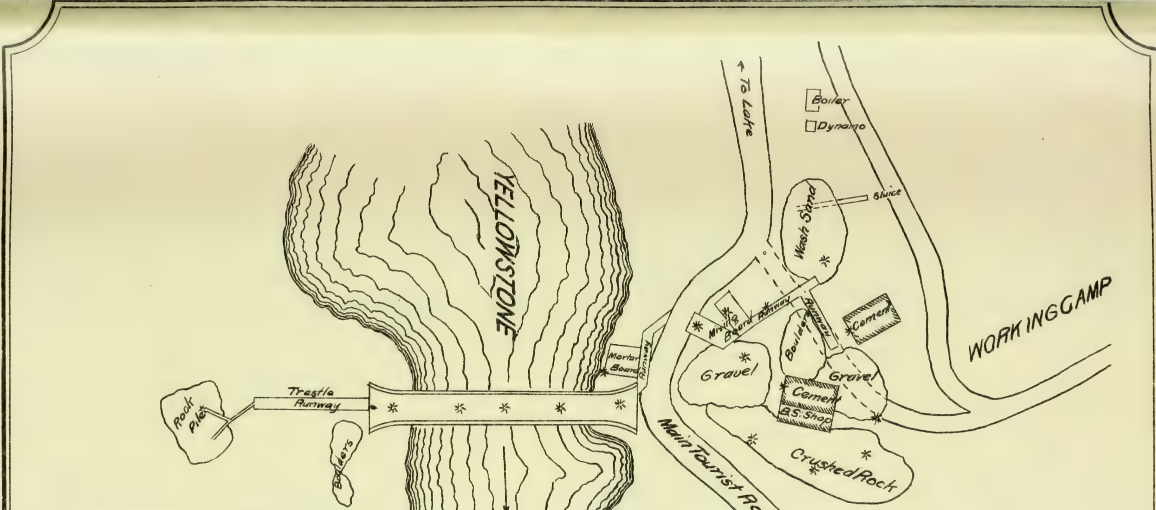
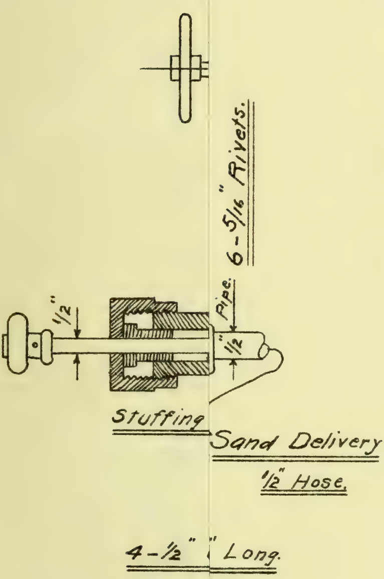


DIAGRAM OF GROUNDS
SHOWING ARRANGEMENTS
FOR PUTTING IN CONCRETE
OF STEEL-CONCRETE BRIDGE
OVER THE
YELLOWSTONE RIVER
U.S. ENGR. OFFICE YELLOWSTONE PARK

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D. C.

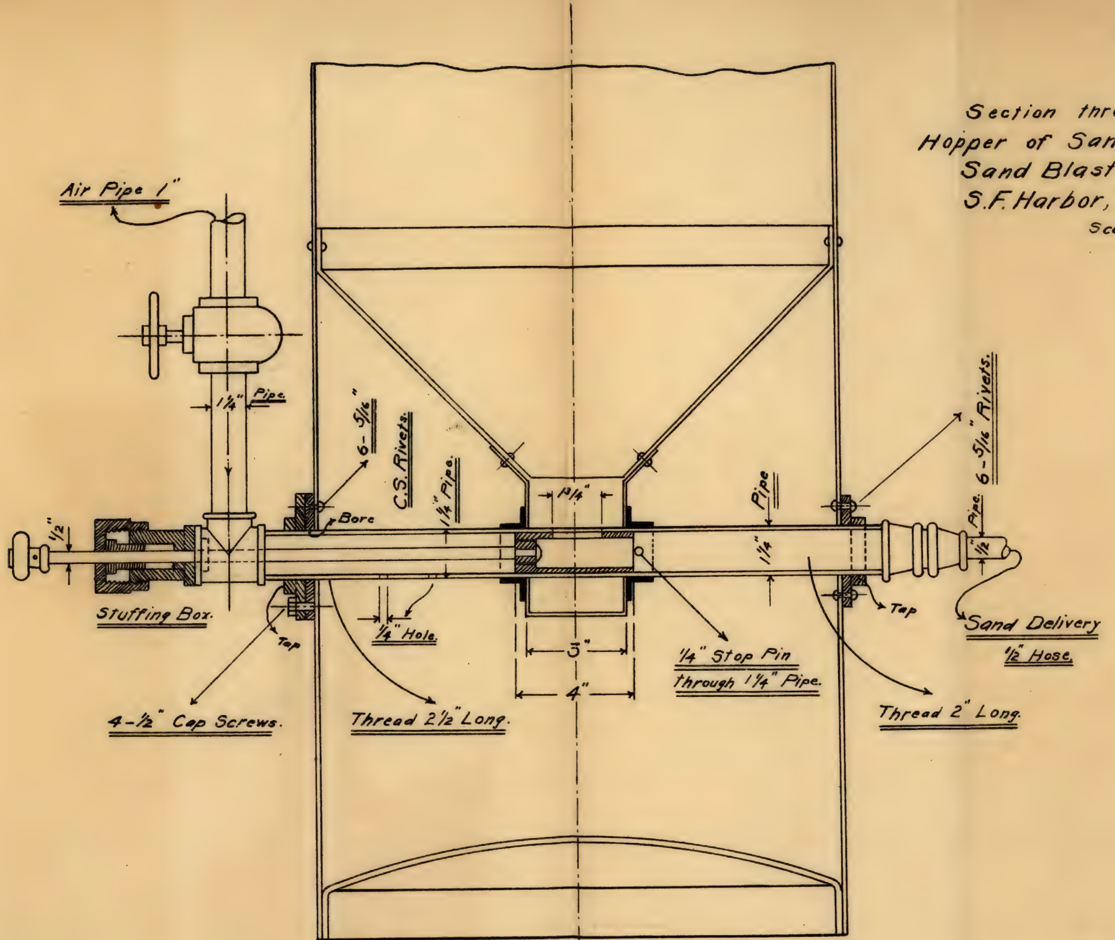
PLATE I.

Section through
...pper of Sand Tank,
Air Pipe ... Sand Blast Plant,
S.F. Harbor, Cal.
Scale 3" = 1'.



ANDREW B GRAHAM, PHOTO-LITHO WASHINGTON

PLATE I.



Section through Hopper of Sand Tank, Sand Blast Plant, S.F. Harbor, Cal.
Scale 3" = 1'.
Air Pipe 1"
1¼" Pipe.
6 - 5/16" C.S. Rivets.
1¼" Pipe.
1¾"
Pipe
1¼"
6 - 5/16" Rivets.
Pipe.
½"
Bore
½"
Stuffing Box.
Tap
¼" Hole.
3"
4"
¼" Stop Pin through 1¼" Pipe.
Tap
Sand Delivery ½" Hose.
4 - ½" Cap Screws.
Thread 2½" Long.
Thread 2" Long.

swift. Upon the pier and abutments above described the false work was built, each half being sustained by five inverted queen-post trusses, as shown in the photograph.

All of the material for the upper work was manufactured beforehand, and its erection moved off with rapidity after the pier and abutments were once in. A large part of the coarse lumber used in the work was sawed in the vicinity, but all of the finer lumber was brought from the Pacific coast. The work was begun on the 23d of May, and the woodwork was practically finished by the 1st of August.

The lumber and timber of all kinds used in the false work and forming amounted to over 80,000 feet. A large part of it was saved and will be available for other uses.

Contrary to the usual practice in putting in structures of this kind, it was decided in the present case not to divide the concrete work into sections, putting in one or more each day, but to carry the work on continuously from start to finish, so that the entire mass might set together as a monolith. The only difficulties in executing the work in this manner are those of organization and the necessity of assembling a large force and working all night. All details were thought out very carefully, and when the concrete was put in the operation passed off without a hitch.

The accompanying diagram shows the grounds and the relation of the different piles of material, the mixing boards, bridge, etc., to each other. A careful system of runways was provided to the various gravel and rock piles and to the cement house. Water was brought from the river in road sprinklers and let out into barrels, whence it was taken in buckets.

The mixing was done by hand on a single board in a rather unusual way. The board was 25 feet long, sloping slightly from one end to the other, and sixteen mixers were employed, eight on each side. The ingredients were dumped on the upper end and the mixing was begun immediately. The first two mixers turned the material dry. Next to them stood a man with water, which he applied after every shovelful. The next mixers kept turning the material along, and another water man assisted in wetting the mixture farther down the line. In this way the whole mass was moved along by a sort of continuous motion, and when the end of the board was reached it was shoveled directly into the carts below, whence it was wheeled to the bridge. Each batch contained about 18 cubic feet and made two cartloads. The rate of mixing was 10 yards per hour. Owing to the excessive evaporation, the mixture was made as wet as it could be handled.

No mortar facing was used except for the road surface, but great pains were taken to get a close contact with the forms and with the steel arch beams.

Concreting was begun at the two abutments or approaches and was finished at the center. No appreciable settlement of the false work was observed.

The work was carried on in three shifts of eight hours each. The time required with the force available was estimated at seventy-five hours. Work began at 7 a. m. August 10 and was finished (except the mortar surface of the roadway) at 10 a. m. August 12, a period of seventy-four hours, with a loss of two hours in all for meals.

The time selected for the work was that of the full moon, but artificial light was also necessary. To provide this, a small dynamo was borrowed of the hotel company and was attached to the rock-crusher

engine and a temporary plant installed on the grounds. The arrangement was entirely successful.

The cost of putting in the concrete was about $1.50 per yard.

The work on the railing was commenced immediately after the main body of the concrete was put in.

The centering of the arch was struck September 8, twenty-eight days after the concrete work was completed. A bench mark for level reference had been established, and the settlement of the structure on the removal of the supports was carefully measured. It amounted to about one-tenth of an inch.

Very slight cracks have appeared over the spring line on both ends of the bridge, showing that the precautions taken to prevent them were not entirely sufficient. The only possible ill effect that can come from these cracks will be due to the infiltration of water, and care will be taken to prevent this.

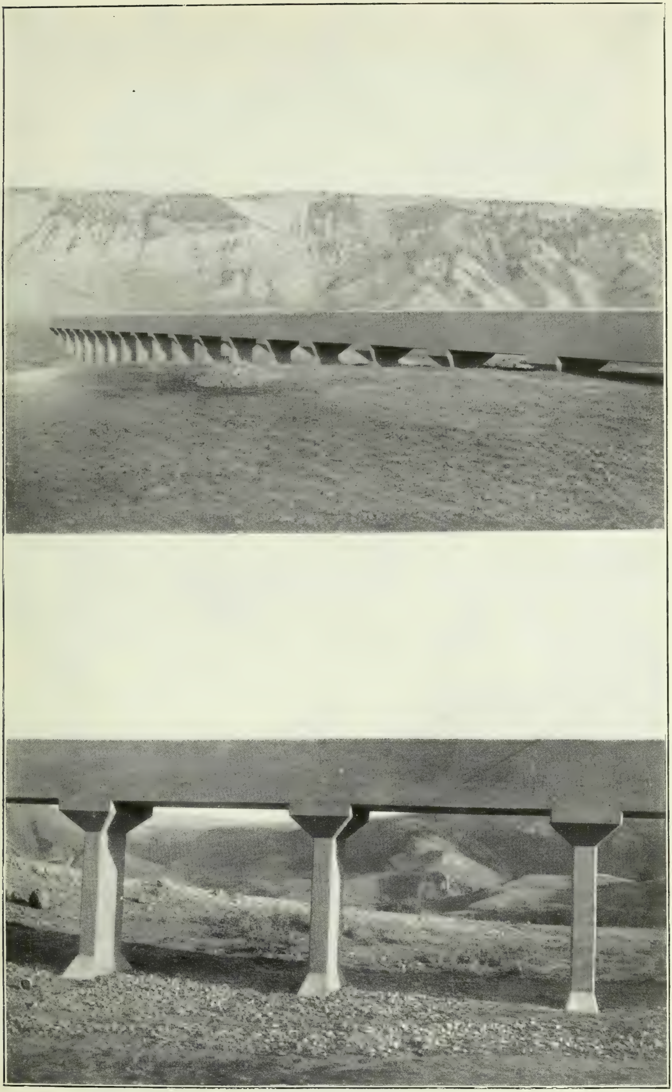
The preparation of the drawings and the supervision of all the work, except the putting in of the false work for the forming, was by Mr. Robert Walker, United States overseer. Owing to the temporary absence of Mr. Walker, the false work was mainly put in by Mr. Frank R. Grunau.

Concrete dam, aqueduct, and fountain at Mammoth Hot Springs.—It is intended to notice under this heading a few features which may be of use to the profession in the execution of similar works.

In building the reservoir for the water supply at Mammoth Hot Springs a concrete dam was used. The dam was a low one, but the principle of construction would apply to one of greater height as well. A section of the dam is shown in the accompanying photograph. The excavation for the foundation was carried down until a good clay soil was reached, and into this sheet piling was driven to a depth considered sufficient to cut off all possibility of underflow. The sheet piling was allowed to project about 6 inches above the bed of the foundation. Upon this bed and inclosing the sheet piling the concrete dam was erected. It was made in sections of 12-foot lengths, with artificial divisions to take up the motion of expansion and contraction. For the purpose of closing these cracks against the leakage of water the following expedient was resorted to: Strips of sheet lead 3½ inches wide and one-eighth inch thick were used. These were placed against the bulkhead of the particular section under construction, and an inch and a half of the width was bent out at right angles so as to be buried in the concrete of the section. Care was taken to pack the mortar well around this sheet lead, so as to cut off all possibility of leakage. After the section was built and the bulkhead removed, the other side of the lead strip was bent out at right angles, except about one-fourth inch, which was left parallel to the section. The adjoining section of concrete was then built up. In this way it was considered that any movement in the sections due to contraction would be readily taken up without strain, and at the same time the crack would be effectually closed. Experience has fully justified this conclusion, as the dam has never shown any leak at these sections, except in one place, where there has been a large and unexplained separation of the sections, due, it is believed, to some movement in the ground itself.

In view of the extensive difficulties experienced in fortifications in making concrete impervious to water, it is of especial interest to note that this dam has been water-tight from the first, showing but very few evidences of filtration of water. This result was secured by using wet

CONCRETE RESERVOIR DAM AT MAMMOTH HOT SPRINGS.



CONCRETE AQUEDUCT.

CONCRETE DISTRIBUTING FOUNTAIN AT MAMMOTH HOT SPRINGS.

concrete, which compacted very thoroughly, and by facing the water side of the dam with mortar put in at the same time with the concrete. It is true that the pressure on the dam is light, the maximum depth being only 6 feet, but it is believed that the same construction could be applied to much higher dams with equally good results.

In erecting an electric-light plant for use at Mammoth Hot Springs water power was employed. It became necessary to convey this water for a distance over a depression in the ground, and as the work was to be of permanent character it was decided to put in a concrete flume and aqueduct.

The aqueduct was made in 12-foot lengths, supported upon vertical piers, as shown in the photograph. The various sections united over the piers. The cracks between the sections were closed with sheet lead, after the manner already described in the case of the concrete dam. The results in this case were not quite as satisfactory, owing, undoubtedly, to the fact that less pains was taken to get the mortar around the bends in the sheet lead. However, the aqueduct is practically water-tight, although at first there was some seepage at the joints.

For the irrigation of the plateau of about 30 acres at Mammoth Hot Springs it was desired to utilize water from the mains for the domestic supply instead of bringing it in an open ditch. To provide for this extra demand a 10-inch main was laid from the reservoir to the highest part of the grounds to be irrigated. This point where it was desired to release the water was about 100 feet below the level of the reservoir, and it was necessary to adopt some method of reducing the velocity of discharge before letting the water out upon the grounds. It was not desirable to adopt a vertical jet on account of the large quantity of water required and the fact that the wind would scatter it over too wide an area. The following expedient was resorted to: A circular basin, 20 feet in diameter and 4 feet deep, was built of concrete, with a carefully leveled upper edge, consisting of a steel band 6 by $\frac{1}{4}$ inches. The water was expected to flow over the edge of this basin into a circular flume built around it. A 6-inch pipe was led from the main to this basin, so that it would discharge horizontally and tangentially to the circumference at the bottom. The result is that the velocity of discharge is entirely taken up in the basin in the form of a circular motion to the water, which, after the basin is filled, flows over the edge into the flume below, whence it is conducted to the grounds. The experiment was successful so far as the main purpose was concerned, but it has been found that, for the amount of water desired, the basin was somewhat larger than necessary, and therefore the water does not ordinarily flow over it in a full sheet around the entire circumference. It has also been found difficult to secure an even flow all around, as the water sucks down over the end of the discharge pipe and bulges up somewhat at the diametrically opposite point, giving a deeper flow on one side than on the other. Except for these two defects in appearance the result is entirely satisfactory.

All of the above works at Mammoth Hot Springs were executed under the immediate supervision of Mr. Robert Walker, United States overseer.

Very respectfully, your obedient servant,

H. M. Chittenden,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. Army.

B B B 20.

[Report of Capt. William W. Harts, Corps of Engineers, on engineer operations in the former Department of North Philippines, and present Department of Luzon, for the period July 1, 1902, to June 6, 1903.[a]]

HEADQUARTERS DEPARTMENT OF LUZON,
OFFICE OF THE ENGINEER OFFICER,
Manila, P. I., June 6, 1903.

GENERAL: I have the honor to submit the following report of engineer work in the former Department of North Philippines and the present Department of Luzon, for the period July 1, 1902, to date,[a] having been relieved from duty per paragraph 10, General Orders, No. 28, Headquarters Department of Luzon, current series.

* * * * * * *

REPAIRS TO ROADS AND BRIDGES.

At the close of the fiscal year 1902 practically all the work in charge of this Office north of the Pasig River had been completed, and with the exception of roads in the vicinity of Manila, for which minor repairs were provided, and the road work in Laguna and Batangas provinces, operations had ended in the territory south of the Pasig.

FIRST ENGINEER DISTRICT.

This district includes the provinces of Cagayan, Isabela, and Nueva Viscaya. The following engineer work was accomplished:

Between Cauayan and Angandanan 1,000 yards of road were repaired, a 50-foot Howe truss bridge was constructed at the Angandanan River crossing, a 50-foot Howe truss bridge was constructed over the Manante River, and an 80-foot trestle bridge over Tagaran River, besides several culverts.

At Cauayan the road from the barracks site to the Rio Grande, 300 yards long, was ditched, graded, and metaled with such material as was at hand.

From the post site at Tumauini to the river landing, 750 yards, an old, neglected road was cleared off, ditched, and reshaped.

About $4,000, Mexican, was expended in the district.

THIRD ENGINEER DISTRICT.

This district includes the provinces of Zambales, Pangasinan, and Benguet. Work was completed about the middle of July, and consisted of the following:

The Pantal bridge across one of the mouths of the Agno River at Dagupan, which was nearly completed during the previous year, was finished by the erection of a 72-foot center span.

At Bayambang a detail of engineer soldiers erected a ferry cable and put the ferry in good running order. Expended $75, Mexican.

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[a] Since which time Capt. Spencer Cosby, Corps of Engineers, has been the engineer officer of the Department.

SIXTH ENGINEER DISTRICT.

The provinces of Rizal, Bulacan, and Cavite compose this district. All work was completed during the previous year, except the repair of the road from the city limits of Manila to Pasay Barracks. All ruts which had developed were filled with stone, ditches were cleared out, and 900 linear yards metaled with gravel. Expended $1,451.51, Mexican.

SEVENTH ENGINEER DISTRICT.

The provinces of Laguna, Batangas, and Tayabas are included in this district. The following work was accomplished:

The road from Calamba to Batangas was completed March 20, having been commenced in October, 1900. Although the work originally contemplated was of an emergency nature, only $150,000, Mexican, having been allotted for the road from Calamba to Nasugbu, distance 80 miles, by means of a subsequent appropriation of the Philippine Commission it was possible to complete a substantial road from Laguna de Bay to Batangas Gulf, 39.5 miles. About 10 miles of the road were built during the current year.

From indications it is probable that a fair road existed where the present one is located. A number of substantial bridges, built some years ago, are still in a good state of preservation, but with this exception and that the grading had to a large part been done, it was necessary to build the road new throughout. In 1899 the old road site was overgrown with vegetation, and mudholes were to be found in frequent succession. The subsoil is of volcanic ashes, and in wet weather it became a mass of sticky mud, through which it was impossible to take wheeled transportation. The first work consisted in clearing and corduroying. As it soon became apparent that temporary work would not suffice for the needs of the Army by reason of the number of garrisons to be supplied and the consequent heavy hauling, it was determined to make the work permanent so far as funds would permit. The fact that garrisons stationed between Batangas and Nasugbu could be supplied with no great difficulty, and therefore extensive road repair not being required between those points, permitted the use of the greater part of the allotment for the Batangas-Calamba end, which amounted, with the funds appropriated by act 311, United States Philippine Commission, to about $240,000, Mexican.

The road as completed is in the following shape: From the Laguna to Calamba, 1 mile, the road is 30 feet wide with a solid rock foundation covered with gravel, and with ample ditches.

Between Calamba and Tanauan the roadway is 16 feet wide, metaled with volcanic tufa 6 inches deep, and covered with 4 inches of gravel or sand or metaled with gravel 6 to 12 inches deep and covered with pit sand. Near Santo Tomas the structure is a 6-inch Telford foundation of volcanic rock, covered with 2 inches of finely pounded disintegrating feldspathic rock with a top dressing of 1 inch of pit sand. The material used here, as elsewhere, was that which was most available. Long hauls and inaccessible quarries prevented anything like uniformity in the road metal used.

From Tanauan to Batangas the character of the metaling varied from a combination of sand and gravel, volcanic tufa and gravel, to a com-

bination of gravel and crushed coral. Near Batangas a very satisfactory section was constructed with trap rock and broken coral intimately mixed, covered with sharp pit sand.

The culverts constructed number 66, and are of three types. First, a box culvert with grouted floor and stone walls, with planked roadway; second, 12-inch cement pipe culvert, and, third, wooden box subdrains.

Five bridges, built prior to American occupation, were repaired, and one bridge, 25-foot span, with stone abutments and pier, was built.

The completed sections of the road were maintained during the whole period of construction. At the time work was completed the road throughout was in excellent condition.

Expended during the year, about $60,000, Mexican.

The road from New Rosario to Taysan, 5½ miles in length, was improved by clearing, ditching, and grading; 5 log culverts were built and 3 stone culverts repaired. The branch roads to the Ibaan and San Juan de Boc Boc roads were gone over and such improvements made as funds would permit. Total length of roads improved was 12 miles. This work was in charge of Capt. D. H. Boughton, Third Cavalry. Amount expended, $5,000, allotted from Calamba-Batangas funds.

The final road work in the department ended with the completion of repairs to the road between Bay and Calauan. During the previous year the road from Bay to San Pablo had been put in shape for transportation of supplies by grading and ditching and metaling the worst places; also by the construction of a number of culverts and two bridges. Lack of sufficient transportation facilities prevented the completion of the work until the time stated.

The section between Calauan and Bay was graded, ditched, and surfaced with hard stone, with a gravel top dressing. The grading for 2,000 yards averaged in fill from 3 to 4 feet. Expended during the year for repairs and permanent work about $20,000.

The work in this district was in charge of First Lieut. George B. Pillsbury, Corps of Engineers, with Lieut. William G. Caples, Corps of Engineers, as assistant, and later by the latter officer. Both of these officers are deserving of special commendation for the resourcefulness and energy with which the work was carried on under adverse and trying conditions.

With the completion of the above operations the proposed road and bridge work in the department ended. The operations cover a period of four years, during which time over $1,500,000, Mexican, was expended for labor and supplies, and exclusive of tools and a large amount of lumber purchased in the United States. The sum total of results accomplished with this outlay amounted to 220 miles of roads metaled, an equal distance of actually improved roads covering a distance of over 1,000 miles, 260 bridges, with a total length of 3½ miles, 20 stone bridges, 1,000 culverts, and 15 ferries; 45 miles of trails were opened up and improved. But little effort has been made by the provincial authorities to maintain improvements made, except in Albay Province. The result of this neglect in a country of rapid deterioration needs no comment.

SURVEYS.

The military zones around the powder magazines at Pandacan, San Juan del Monte, and San Francisco del Monte were surveyed, maps submitted, and boundaries marked.

SECTION OF CALAMBA-BATTANGAS ROAD, BUILT BY U. S. ENGINEERS.

Within the city of Manila and vicinity lands occupied by the military authorities were surveyed and maps submitted; this included lands occupied by Fort San Antonio Abad, Malate Barracks, Luneta Barracks, and Camp Wallace Field, storehouses and morgue, Fort Santiago, Cuartel España, Cuartel Fortin, Army and Navy Club, and Estado Mayor.

Surveys for the location of new military posts were made at Los Banos, Santo Tomas, Batangas, Mariveles, Corregidor, Bayambang, Malahi Island, Fort William McKinley, and Calamba.

Estimate and bill of material were prepared by Lieut. William G. Caples for a water-supply system at Los Banos and special survey made for location of water system.

Plans, estimates, and investigation of titles in addition to surveys were made by Lieutenants Rand and Pillsbury in connection with proposed posts.

The department engineer officer prepared plans and estimates for water and sewerage systems at Fort William McKinley and Malahi Island, and for a water system at the post site near Batangas.

WORK AT FORT WILLIAM M'KINLEY.

The preliminary work is, by direction of the division commander in charge of the department engineer officer, under the direction of the board of construction. The local supervision has been successively in charge of Lieutenants Markham, Lukesh, and Rand.

The work has progressed as follows: The necessary temporary buildings for the engineer detachment were built, also stables and sheds for transportation and protection of property. All necessary post-roads were staked out and sites for barracks and quarters located. A hydrographic survey of the Pasig and Taguig rivers was made, a 50-acre plot of ground set aside for the agricultural bureau of the civil government for experimental purposes was surveyed and staked out, a survey was made for the location of the proposed water and sewerage systems, and monuments marking the boundaries of the reservation were built.

Projects for water and sewerage systems were prepared, the former including three artesian wells, one of which has been sunk to a depth of 1,005 feet, from which a good supply of water was obtained; the second well has been sunk to a depth of 570 feet. These wells are being sunk under contract, the supervision being under the engineer officer of the department.

Roads leading from the entrance to and in front of the line of officers' quarters, in rear of the First Regiment barracks site, in front of the barracks site and in rear of the officers' quarters, and to the hospital site are well under way, about 2½ miles of road having been completed. A branch road to the site for quartermaster stables has been completed.

The work of erecting barracks has been commenced, and the grading for these barrack sites carried forward as fast as required.

As the work has progressed, the wisdom of selecting the site for a large post has been apparent. The ground is high, the drainage good, and the water supply will apparently be abundant and of excellent quality. The conformation of the ground has permitted the location of the quarters, barracks, and other post buildings advantageously.

Upon completion under the present approved plans this post should be a model one for a tropical country.

Very respectfully,

WM. W. HARTS,
Captain, Corps of Engineers, U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

APPENDIX C C C.

BRIDGES AT WASHINGTON, DISTRICT OF COLUMBIA.

REPORT OF LIEUT. COL. CHARLES J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDED JUNE 30, 1903.

1. Repair of the Aqueduct Bridge across Potomac River at Washington, District of Columbia.
2. Memorial bridge across Potomac River at Washington, District of Columbia.
3. Highway bridge across the Potomac River at Washington, District of Columbia.

United States Engineer Office,
Washington, D. C., July 31, 1903.

General: I have the honor to forward herewith * * * my annual report for year ended June 30, 1903, for Memorial bridge, repairs to the Aqueduct Bridge, and highway bridge across the Potomac River at Washington, D. C. * * *

Very respectfully, your obedient servant,

Chas. J. Allen,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

C C C 1.

REPAIR OF THE AQUEDUCT BRIDGE ACROSS THE POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1903.

(*a*) RECONSTRUCTION OF PIER NO. 5.

The contractor for reconstructing pier No. 5 commenced preparations for the work in June, but had not at the close of the fiscal year started the construction.

Money statement.

Appropriated by act of July 1, 1902	$65,000.00
June 30, 1903, amount expended during fiscal year	1,146.16
July 1, 1903, balance unexpended	63,853.84
July 1, 1903, outstanding liabilities	25.00
July 1, 1903, balance available	63,828.84
July 1, 1903, amount covered by uncompleted contracts	54,956 00

(b) REPAIRS TO REMAINING PIERS.

Congress, by joint resolution of July 1, 1902, authorized the Secretary of War to expend an amount not exceeding $3,000 from the balance of appropriations made for the reconstruction of pier No. 4 of the Aqueduct Bridge for examination and inspection of the remaining piers of this bridge and for such temporary repairs as the examination, etc., may show to be necessary.

No work of repairs was done during the year.

Money statement.

July 1, 1903, amount available (joint resolution, July 1, 1902)	$3,000.00

CONTRACT IN FORCE.

Contractor: Penn Bridge Company, of Beaver Falls, Pa., for reconstructing pier No. 5 of Aqueduct Bridge.

Estimated amount of contract: $54,956.

Date of contract: April 22, 1903.

Approved: May 18, 1903.

Date of commencement: May 1, 1903.

Date for completion: December 1, 1903.

C C C 2.

MEMORIAL BRIDGE ACROSS POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA.

No work of construction has ever been done.

Money statement.

July 1, 1902, balance unexpended	$219.95
June 30, 1903, amount expended during fiscal year	1.00
July 1, 1903, balance unexpended (deposited in Treasury)	218.95

C C C 3.

HIGHWAY BRIDGE ACROSS THE POTOMAC RIVER, WASHINGTON, DISTRICT OF COLUMBIA.

WORK OF THE FISCAL YEAR ENDED JUNE 30, 1903.

Considerable preparatory work was done during the year.

Under date of February 6, 1903, public advertisement was made inviting proposals for construction of the bridge. The resulting bids, opened on March 27, were all in excess of the amount available.

A new advertisement was issued June 10, bids to be opened July 25, 1903.

Money statement.

Amount appropriated by act of July 1, 1902	$996,000.00
Amount expended to June 30, 1903	[a] 9,530.93
July 1, 1903, balance unexpended	986,469.07
July 1, 1903, outstanding liabilities	150.00
July 1, 1903, balance available	986,319.07

[a] Of this amount $5,500 was expended under act of February 12, 1901.

APPENDIX D D D.

WASHINGTON AQUEDUCT, INCREASING THE WATER SUPPLY OF WASHINGTON, DISTRICT OF COLUMBIA, AND WASHINGTON AQUEDUCT, DISTRICT OF COLUMBIA, FILTRATION PLANT.

REPORT OF LIEUT. COL. A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., July 20, 1903.

GENERAL: I have the honor to forward herewith the annual reports for Washington Aqueduct, increasing the water supply of Washington, D. C., and Washington Aqueduct, District of Columbia, filtration plant.

Very respectfully, your obedient servant,

A. M. MILLER,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

D D D 1.

WASHINGTON AQUEDUCT.

Appropriations for the Washington Aqueduct are applied to the improvement, maintenance, and repair of all of those parts of the water supply which have been placed under the supervision of the Chief of Engineers. These are the masonry dam across the Potomac at Great Falls, the works there for regulating the supply to the conduit, the Conduit road from Great Falls to Washington, a distance of about 14 miles, the conduit from Great Falls to the distributing reservoir, the three reservoirs for supplying the city, the mains for delivering water from the reservoirs into the city's distributing system, the two bridges for carrying the mains across Rock Creek, and the new reservoir near Howard University and the tunnel connecting it with the distributing reservoir.

The water supply is taken from the Potomac River at Great Falls, about 14 miles above the city.

At this point a masonry dam extends across the river from the Maryland to the Virginia shore. Its total length is 2,877 feet, and the width of its crest in the Virginia channel and across Conns Island is 8 feet

3 inches and in the Maryland channel 7 feet 9 inches. In 1895–96 the crest of the dam was raised from a reference of 148 feet above mean tide at the Washington Navy-Yard to 150.5 feet above the same datum plane.

The top of the mouth of the feeder of the conduit at Great Falls is at a reference of 149 feet and the bottom at a reference of 139.5 feet.

The water passes from the feeder through the gatehouse and into the conduit, which at this point has a reference of 152 feet at the interior surface of the crown of the arch.

The slope of the conduit is uniform between the gatehouse at Great Falls and the distributing reservoir and is 9 inches in 5,000 feet.

The conduit is circular in cross section, and for the greater part of its entire length is 9 feet in diameter and composed either of rubble masonry plastered or of three rings of brick, but where the soil in which it was built was considered particularly good the inner ring of brick was omitted and the diameter is 9 feet 9 inches. Where the conduit passes as an unlined tunnel through rock, the excavation was sufficient to contain an inscribed circle 11 feet in diameter.

The lengths of the conduit and its connections are as follows:

Length of feeder at Great Falls, 256 feet.

Area of cross section at mouth, 157.45 square feet.

Length of conduit between gatehouse at Great Falls and north connection of Dalecarlia reservoir, 47,896.5 feet; least diameter, 9 feet.

Length of by-conduit around Dalecarlia reservoir, 2,730.5 feet; diameter for 625 feet, 8 feet; for rest of distance, 9 feet.

Length of conduit between south connection of the Dalecarlia reservoir and north connection of the distributing reservoir, 10,149.87 feet; diameter of conduit, 9 feet.

Length of by-conduit around the distributing reservoir, 2,274.35 feet; diameter, 7 feet.

The interior surface of the crown of the arch of the conduit at the north connection of this reservoir has a reference of 141.87 feet.

At the distributing reservoir the water passes into 4 cast-iron mains 48 inches, 36 inches, 30 inches, and 12 inches in diameter, respectively.

The Dalecarlia reservoir has a storage capacity of about 150,000,000 gallons, is practically without paved slope wall, is perfectly protected against pollution from the drainage of the surrounding country, and is provided with a spillway, the reference of the bottom of which is 146.5 feet. The reference of the interior surface of the crown of the arch of the conduit at the north connection of this reservoir is 143.77 feet and at the south connection 143.39 feet. The distance between these points, measured along the line of flow of the water across the reservoir, is about 3,550 feet.

The distributing reservoir has a storage capacity of about 150,850,000 gallons and is divided by a puddled and paved wall, through which is a passageway which can be closed with stop planks, into two sections, containing 97,600,000 and 53,250,000 gallons, respectively.

The Georgetown high-service reservoir is circular in plan and has an available capacity of about 1,500,000 gallons. The reference of its water surface when the reservoir is full is 220.5 feet. Although this reservoir is under the charge of this Office, the duty of keeping it filled by pumping devolved upon the water department of the District of Columbia until it was taken out of service, November 17, 1897, at the request of the Commissioners of the District of Columbia, the Fort

Reno reservoir and the pumping service having rendered its further use inadvisable except in case of emergency.

On January 8, 1902, the Washington Aqueduct tunnel and the Washington City reservoir were placed in service. This addition increased the head throughout the entire gravity system by from 12 to 20 feet. The Washington City reservoir is situated near the Soldiers' Home and has a capacity of 300,000,000 gallons.

In addition to the four reservoirs already mentioned, which form a part of the aqueduct system, there is another reservoir, built and controlled by the Commissioners of the District of Columbia, called the Fort Reno reservoir, with a capacity of about 4,500,000 gallons, the reference of its water service when the reservoir is full being about 420 feet. This reservoir is supplied with water taken from the supply mains by the U street pump.

The Dalecarlia, Georgetown distributing, and Washington City reservoirs supply that part of the District which lies below 90 feet above datum. The areas lying between the levels of 90 and 220 feet above datum are supplied by pumping from the U street station directly into the distributing mains, and by the use of the new Brightwood reservoir, built by the Commissioners of the District of Columbia, and having a capacity of 30,000,000 gallons, the Georgetown high-service reservoir being held as a reserve supply. The areas having a greater elevation than 220 feet above datum are supplied from the Fort Reno reservoir.

It will be observed, therefore, that the total present storage capacity of all reservoirs is about 637,000,000 gallons, or about eleven days' normal supply.

Until the average daily consumption of water becomes considerably greater than at present the reference of the surface of the water at the lowest stage of the Potomac will be about 151 feet at the mouth of the feeder at Great Falls, about 146.75 feet at the Dalecarlia reservoir, and 146 feet at the Georgetown distributing reservoir.

The total supply of water which the present conduit can safely furnish, without a pressure dangerous to its safety, is 76,000,000 gallons per diem. This, however, necessitates the lowering of the Georgetown distributing reservoir to reference 144, thus involving a loss of head of 2 feet at that point of distribution.

The following statement shows the operations upon the aqueduct and its accessory works during the fiscal year and their condition at its close:

THE DAM AT GREAT FALLS.

The riprap backing of the dam at Great Falls was repaired by replacing 1,015 cubic yards which had been carried away by floods. The grounds around the mouth of the conduit at the Maryland end of the dam were graded and a new fence erected.

GATEHOUSES AND BUILDINGS.

The old revolving screen machinery was removed from the gatehouse at Georgetown distributing reservoir.

All the gatehouses and gate keepers' houses and storehouses were put in good repair and the necessary painting, cement washing, and whitewashing were done.

THE RESERVOIRS.

The grounds at the reservoirs were kept in good order; all gutters and culverts were cleaned, fences repaired and whitewashed.

At the Georgetown distributing reservoir the grounds around the west-shaft gatehouse were graded, fenced, and sodded.

The following table gives the fluctuation from and including the year 1894-95 to date, June 30, 1903, of the level of the water in the Georgetown distributing reservoir:

Year.	Lowest.	Date.	Highest.	Date.	Range.
	Feet.		*Feet.*		*Feet.*
1894-95	141.45	February, 1894	145.55	March, 1895	4.1
1895-96	144.15	July, 1895	145.95	April and May, 1896	1.8
1896-97	145.08	January 30, 1897	146.08	November 29, 1896	1
1897-98	145.65	February 2, 1898	146.10	April 27, 1898	.45
1898-99	144.55	February 16, 1899	146.05	April 16, 1899	1.5
1899-1900	141.25	June 27, 1900	145.98	December 27, 1899	4.73
1900-1901	141.01	June 26, 1901	145.90	January 12, 1901	4.89
1901-2	142.50	October 14, 1901	146.15	April 8, 1902	3.65
1902-3	141.21	December 31, 1902	146.62	September 6, 1902	5.41

THE CONDUIT AND CONDUIT ROAD.

Gutters, ditches, culverts, and drains were cleaned, grass and weeds were cut along the road embankments, and new gutters and drains constructed where necessary. All fences along the Conduit road were repaired and whitewashed.

The earth filling over a portion of the by-conduit at the Dalecarlia reservoir was raised to a proper grade to prevent overflow from the reservoir.

The riprap walls at waste weir No. 1 and Dalecarlia reservoir were repaired.

Two thousand six hundred and fifty cubic yards of stone were crushed and spread on the Conduit road between the Dalecarlia and Georgetown distributing reservoirs.

The dirt road between the Club House and Great Falls was repaired, and small repairs were made to the macadam road where needed.

THE BRIDGES.

Small repairs were made to the floors of Cabin John and Dalecarlia reservoir bridges, and a new floor was placed on the Rock Creek bridge.

The roadway of Pennsylvania avenue, which in the vicinity is 53.5 feet in the clear width, is contracted on the bridge over Rock Creek to a clear width of but 17 feet, and as drivers are required to walk their teams while passing over the bridge, a congestion of travel results during the busiest hours of the day, causing delay and annoyance, as there is not room for one team to pass another, and consequently the speed of all teams on the bridge moving in the same direction is limited by that of the team in front. Especially is this annoyance felt by the thousands of bicycle riders who daily pass over the bridge, and who, unless experienced riders, are frequently forced to dismount and lead their bicycles over the bridge, the rate of progress of the teams blocking the roadway ahead being too slow to allow an inexperienced rider to maintain equilibrium. In addition, the sightly appearance of the avenue is much injured by the extreme contraction at this point.

This bridge, the property of the Washington Aqueduct, is very graceful in appearance and is unique among the bridges of the world, in that the roadway is supported upon arched ribs formed by two 48-inch cast-iron pipes, through which flows about half of the water consumed by the city. It would seem, therefore, that any plan to widen the bridge should preserve both the graceful form and the distinctive features of the bridge.

A board of engineers, constituted by Special Orders, No. 8, February 2, 1877, and composed of the following officers of the United States Corps of Engineers: Bvt. Maj. Gen. Z. B. Tower, Bvt. Maj. Gen. H. G. Wright, and Bvt. Maj. Gen. Q. A. Gillmore, was assembled to examine into the propriety of certain proposed modifications of this bridge. This board, after due consideration of the matter, reported as follows:

It would, in our opinion, therefore, better accord with the position on Pennsylvania avenue and with the general character and architectural effect of other aqueduct structures to widen this structure, without changing its design, by the addition of two arched iron ribs similar to those of the present bridge and by widening the abutments.

These two arched ribs should be made about as heavy as those of the present bridge. As the previous discussion shows the latter to be abundantly strong without the truss work, in the new construction the greater portion of the whole weight of the bridge could be thrown upon the added arches not used as water pipes.

We regard the arch as far more sightly, beautiful, and architectural than the truss, and therefore more suitable for this position.

On April 26, 1877, the late Gen. Thomas L. Casey, United States Corps of Engineers (retired), then in charge of the Washington Aqueduct, was requested by the Chief of Engineers to investigate and report upon "the present and prospective use of that bridge as a highway," etc. This he did on July 19, 1877, his report concluding with the following opinion:

I am further of opinion that the present and prospective interests of the citizens of Washington and Georgetown do demand an increase in the width of the roadway and of the footways, the present width being, of the roadway only 17 feet, and of the footways 4½ feet each.

The abundant strength and stiffness of the present bridge, under any statical or moving loads that are likely to be placed upon it, are clearly shown by the investigations of the Board of Engineers, as detailed in its report of April 7, 1877, and I agree with it as to the manner in which the widening of the road and footways should be accomplished should it be decided to increase their width, namely, by the addition of two arched iron ribs, similar to those of the present bridge, and by widening the abutments. The estimated cost of widening the bridge in the manner above stated is $75,000.

While it is believed that the interest and convenience of the citizens of Washington and Georgetown demand the widening of this bridge, yet because the present structure amply suffices for all requirements of the Washington Aqueduct system, and because during the past few years no official complaints regarding the width of the bridge have been made to this Office, no estimate is submitted for this work, the estimate for the next fiscal year being confined to those subjects directly affecting the operation of the Washington Aqueduct.

THE MAINS.

The trunk mains, aggregating 21 miles in length, which lead from the Georgetown distributing reservoir and supply the distributing system of street mains, were laid by the United States and are under the

control of this Office, but the distributing mains were laid by the city of Washington and the District of Columbia, and are under the care and control of the Commissioners of the District.

The vaults on the pipe line were cleaned and the valves worked and oiled. A broken blow-off valve on the 48-inch main and a break in the 12-inch main on Canal road were repaired.

The District of Columbia water department made a 36-inch connection with the 48-inch main at Fourth and R streets NW.

THE TELEPHONE LINE.

Numerous small repairs were made to the telephone line.

CONSUMPTION AND WASTE OF WATER.

Measurements of the daily and hourly consumption and waste of water were made on June 25–26, 1903, and a detailed record of the measurements is given in the following table:

Measurements of the daily and hourly consumption and waste of water.

[Hourly and total flow from the Georgetown distributing reservoir for the twenty-four hours ending at 8 a. m.]

Hour.	Height above datum.	Consumption and waste.	Hour.	Height above datum.	Consumption and waste.
	Feet.	*Gallons.*		*Feet.*	*Gallons.*
8 a. m	145.60	....	10 p. m	142.94	2,341,345
9 a. m	145.39	2,955,170	11 p. m	142.78	2,200,608
10 a. m	145.19	2,809,531	12 midnight	142.62	2,197,404
11 a. m	144.99	2,804,684	1 a. m	142.47	2,057,164
12 noon	144.80	2,660,015	2 a. m	142.31	2,191,464
1 p. m	144.60	2,795,231	3 a. m	142.17	1,914,850
2 p. m	144.41	2,650,924	4 a. m	142.03	1,912,548
3 p. m	144.20	2,924,994	5 a. m	141.88	2,046,386
4 p. m	144.01	2,641,715	6 a. m	141.70	2,451,764
5 p. m	143.81	2,776,082	7 a. m	141.50	2,719,578
6 p. m	143.63	2,494,256	8 a. m	141.29	2,850,331
7 p. m	143.45	2,490,377			
8 p. m	143.28	2,348,497	Total	....	59,579,900
9 p. m	143.11	2,344,982			

City temperature in the shade at 2 p. m. June 25, 70° F., weather clear.

Measurements of the daily and hourly consumption and waste of water were made each month except September, 1902, and February, 1903. The amounts are given in the following table:

	Gallons.
July 23–24, 1902	59,789,688
August 26–27, 1902	58,954,001
October 21–22, 1902	58,713,476
November 21–22, 1902	54,708,167
December 30–31, 1902	60,676,440
January 27–28, 1903	61,563,320
March 6–7, 1903	56,632,512
March 30–31, 1903	54,138,269
April 30–May 1, 1903	58,080,448
May 27–28, 1903	57,777,892
June 25–26, 1903	59,579,900

or an average of eleven measurements of consumption and waste for the fiscal year of 58,237,646 gallons.

The following table gives the daily consumption of water by the District of Columbia as furnished by the Washington Aqueduct:

Date.	Daily consumption.	Population.	Amount per capita per diem.
	Gallons.		Gallons.
1874	17,554,848	a 130,182	134
1875	21,000,000	a 138,091	152
1876	24,177,797	a 146,000	165
1877	23,252,932	a 153,909	151
1878	24,885,945	a 161,818	154
1879	25,947,642	a 169,727	153
1880	25,740,138	b 177,638	145
1881	26,525,991	a 182,893	145
1882	29,727,864	a 187,968	158
1883	24,314,715	a 193,133	126
1884	24,827,113	a 198,198	125
1885	25,219,194	c 203,459	124
1886	25,542,476	a 208,358	123
1887	26,878,424	a 213,357	126
1888	29,115,774	a 218,157	133
1889	27,708,779	a 225,309	123
1890	35,541,845	b 232,460	153
1891	38,594,743	a 248,539	155
1892	41,161,780	c 264,618	156
1893	46,727,108	a 267,569	171
1894	49,162,357	c 270,519	182
1895	47,182,681	a 272,677	173
1896	44,113,574	a 274,815	161
1897	45,467,047	c 276,963	163
1898	47,288,733	a 277,548	170
1899	50,079,855	a 278,133	180
1900	50,897,227	b 278,718	183
1901	53,960,998	a 279,293	193
1902	57,474,790	a 279,878	205
1903	59,579,900	a 280,463	212

a Estimated. b United States census. c Police census.

From the above it will be observed that the consumption and waste of water in the District of Columbia for June 25, 1903, was 59,579,900 gallons per diem. This is the largest June measurement ever taken, and estimating the population of the District of Columbia as 280,463 gives a daily per capita consumption and waste of 212 gallons.

Careful and trustworthy investigations and measurements made in various cities in the United States show clearly that a per capita daily consumption of 100 gallons is ample for all domestic, business, and public purposes, and that any considerable increase above this amount must be attributed to waste, due to defective mains and service pipes, defective plumbing, and willful waste.

This extravagant use of water has become a serious menace to the supply of water by the Washington Aqueduct with its present capacity. The capacity of the aqueduct, with a head of 146 feet at the distributing reservoir, a head necessary to keep up the present pressure for the gravity supply, is 50,000,000 gallons per diem. If the level of the distributing reservoir were lowered to 144 feet, the ultimate safe limit of supply is 76,000,000 gallons. This latter involves a loss of head of 2 feet, so that to obtain the same pressure with the supply additional pumping would be required.

The present consumption and waste has also an important bearing on the subject of filtration.

A filtration plant has been authorized by Congress and is now being constructed by this Office. It is probable that the cost of filtration will be about $6 per million gallons, or, at the present rate of consumption, about $300 per day, or $110,000 annually. This is a large charge and can only be reduced by a reduction in consumption.

The existing conditions suggest two remedies, either the reduction of consumption to a reasonable rate, 100 gallons per capita per diem, or the increase of the present supply to keep up with the present unreasonable and extravagant demand of 212 gallons per capita per diem.

The first remedy, the reduction of consumption, can only be accomplished by the introduction of meters. This is a positive and certain method and has been shown by actual experience to be perfectly feasible. However, whenever this subject of the introduction of meters has been brought to the attention of Congress it has failed to meet approval.

Capt. Edward Burr, Corps of Engineers, U. S. Army, when in charge of the water department of the District of Columbia, made an able and exhaustive report on this subject. (See Report of the Commissioners of the District of Columbia for the fiscal year ending June 30, 1897, Vol. II, p. 181, et seq.)

Captain Burr says (pp. 189–191):

A résumé of the above figures as to per capita use of water is—

	Gallons.
For domestic purposes, 27, or, say	30
For commercial and United States purposes, 27, or, say	30
For sprinkling (maximum), 12, or, say	15
Total maximum legitimate use	75

Add for waste, not deliberate or willful, 25 gallons, and the total is 100 gallons per capita, or 28,000,000 gallons a day. With such an allowance and supply of water there would be ample for all purposes—domestic, commercial, and public. There would be no necessity for stinting or economy in any legitimate use of water. All that is necessary is the suppression of careless, deliberate, and willful waste, due to defective plumbing, known or unknown, and positive personal violations of regulations in opening fixtures to allow water to run continuously.

There is but one means to fully control and suppress such waste—the general extension of the meter system to all classes of consumers, domestic as well as commercial. Until this means is adopted periodical shortages in the water supply of this city must be expected, not because the supply of water is insufficient for all legitimate uses, but because 70 per cent of it is wasted and serves no good end whatever.

That the general introduction of meters will accomplish this end without hardship, increased cost to consumers, insanitary conditions, or any curtailment of the proper use of water, there can be no doubt. The opinion of all authorities and the experience of all communities where the meter system has been generally introduced lead to this belief. By the use of meters is obtained a suppression of waste, a uniformity of water rates according to the amount of water used or wasted, and an increase of pressure, with a general improvement of the service without the expenditure of large sums for enlargements of works.

To illustrate the benefits of the meter system it is necessary to refer to but one city, Detroit, with about the same population as the District of Columbia. The following quotations are taken from a statement made by Mr. L. N. Case, superintendent of the Detroit waterworks, before a committee of the legislature of the State of Michigan, having under consideration what is known as the "free-water bill" for Detroit:

"There has been found but one really efficient restriction to waste, and that is the meter, although assessing upon the basis of consumption as estimated is partially so. * * *

"For years, and up to 1889, Detroit, Buffalo, and Philadelphia operated upon the assessment plan entirely. Detroit pumped a daily per capita supply of 204 gallons. Our capacity was more than exhausted, and complaints of short supplies were bitter and increasing. March 6, 1889, I demonstrated to the board that meters must be used to stop this enormous waste or an enlargement of the works entered into immediately, at an estimated expense of $600,000.

"The introduction of meters was decided upon. The following conditions of the three cities in 1887 and 1896 will show the results of the introduction of meters in Detroit and the continuance of the old method in Buffalo and Philadelphia:

Daily pumpage, in million gallons.

	Buffalo.	Philadelphia.	Detroit.
1887	38	88	36
1896	101	239	36
Increase in population ...per cent..	34	46	56

"Detroit, at the same rate of increase as Buffalo and Philadelphia, which corresponded exactly with her increase previous to using meters, would have pumped 101,000,000 gallons daily. This would have required an expenditure of over $200,000 for engines and pipes more than was expended, and an extra expense for pumping water of $94,900 for last year, with a proportionate increase for the intervening years."

* * * * * * *

One-third increased pressures.

The result in Detroit is a stationary total consumption for ten years, with a 56 per cent increase in population and a per capita decrease from 203 to 130 gallons. This was accomplished by metering about 5,000 consumers of a total of 49,000, and while the effect is marked the per capita supply still shows large waste that can be reduced by increasing the number of meters.

In this city (Washington) the increase in the use of meters has produced a similar but no less marked effect. The existing law requires the use of meters only by hotels, livery stables, manufacturing establishments, and other large consumers. Since 1894 all such consumers have been required to use meters. The following table shows the result:

	1894.	1895.	1896.	1897.
Number of premises supplied	44,185	45,675	46,908	48,540
Number of meters	202	231	574	777
Water supplied ...gallons..	49,162,000	47,182,000	44,114,000	45,267,000
Per capita ...do....	181	173	165	164

With an increase since 1894 of 4,355 in the number of premises supplied with water, the total daily supply is reduced by about 4,000,000 gallons and the per capita supply from 181 to 164 gallons.

This can be attributed to no other cause than to the metering of about 500 large consumers of the character mentioned above.

The introduction of the meters will not prevent an abundant supply for all purposes, will result in a less water rate or expense to consumers, and would throw the burden of waste where it belongs, on the shoulders of the careless and willfully negligent consumers.

The second remedy is an increase of the water supply to meet future demands at the present extravagant rate of consumption.

This involves the building of a second conduit from the Great Falls of the Potomac, with the necessary reservoirs, if any, and proper gatehouses and operating plant. In order that this subject may have proper consideration, with due deliberation and prevision, a survey of practicable routes is essential. These surveys should be taken in hand at once, and an estimate for such surveys is submitted with this report.

STOREHOUSE AND STABLE AT GREAT FALLS.

A suitable storehouse and stable should be erected at Great Falls for the storage of tools and implements belonging to the United States and the stabling of the watchman's horses, which are a necessity to him for the proper performance of his duties. For this an estimate of $3,000 is submitted.

ESTIMATES.

For building combined storehouse and stable at Great Falls $3,000
For preliminary surveys for additional conduit from Great Falls 8,000
For operation, maintenance, and repair of the aqueduct and its accessories, including the Conduit road, the Washington City reservoir, and the Washington Aqueduct tunnel 33,000

Total 44,000

Money statement.

Amount appropriated by act approved July 1, 1902 .... $33,000.00
June 30, 1903, amount expended during fiscal year 31,911.05

July 1, 1903, balance unexpended 1,088.95

July 1, 1903, outstanding liabilities 1,088.95

Amount that can be profitably expended in fiscal year ending June 30, 1905. 44,000.00

Appropriations made for the Washington Aqueduct, with the dates of acts for the same.

Date.	Amount.	Date.	Amount.	Date.	Amount.
September 30, 1850	$500	January 23, 1873	$14,000	March 2, 1889 [i]	$20,000
August 31, 1852 [a]	5,000	March 3, 1873 [c]	43,600	August 6, 1890 [j]	25,500
March 3, 1853	100,000	June 23, 1874 [d]	36,400	March 3, 1891 [k]	20,000
March 3, 1855	250,000	March 3, 1875	26,000	July 14, 1892	20,000
August 18, 1856	250,000	July 31, 1876	22,000	March 3, 1893	80,000
March 3, 1857	1,000,000	March 3, 1877	15,000	August 7, 1894 [m]	82,500
June 12, 1858	800,000	June 20, 1878	15,000	March 2, 1895 [n]	71,500
June 25, 1860	500,000	March 3, 1879 [e]	20,000	June 11, 1896 [o]	25,000
July 4, 1864	150,000	June 4, 1880 [f]	20,000	March 3, 1897 [p]	26,000
July 28, 1866	142,584	March 3, 1881	20,000	June 30, 1898	22,000
December 20, 1866	12,000	July 1, 1882 [g]	20,000	March 3, 1899	25,000
March 2, 1867	20,000	March 3, 1883	20,000	June 6, 1900 [q]	37,000
July 25, 1868	52,500	July 5, 1884	20,000	March 1, 1901	22,000
March 3, 1869	25,000	February 25, 1885	20,000	July 1, 1902	33,000
July 15, 1870 [b]	120,822	July 9, 1886	20,000		
March 3, 1871	114,196	March 3, 1887	20,000	Total	4,494,657
June 10, 1872	70,555	July 18, 1888 [h]	20,000		

NOTE.—Reverted to the Treasury: (*a*) $2.81, (*b*) $46.25, (*c*) $560.87, (*d*) 35 cents, (*e*) $1,109.87, (*f*) $381.06, (*g*) $1,354.17, (*h*) $2,266.34, (*i*) $4.12, (*j*) $5,500, (*k*) $2.49, (*m*) $39.96, (*n*) $2,983.87, (*o*) $285.85, (*p*) $1,828.53, $4.38 from regular appropriation for Washington Aqueduct, $1,824.15 from appropriation for constructing telephone line, and (*q*) $1,450.02 from appropriations for protection to inlet at Great Falls and repairing by-conduit; total, $17,816.56. Since 1878 one half of the amounts appropriated has been contributed by the United States and the other half by the District of Columbia.

Appendix 1.—Condition of the water during the year.

Condition of the water at Great Falls, Dalecarlia receiving, Georgetown distributing, and Washington City reservoirs, and height of water over the dam at Great Falls for each day during the year.

Day of month.	Condition of water. Great Falls.	Dalecarlia receiving reservoir, south connection.	Georgetown distributing reservoir, effluent gatehouse.	Washington City reservoir, effluent.	Height of water over the dam at Great Falls (feet).
1902.					
July 1	4	7	5	36	0.70
2	5	9	6	36	.70
3	4	7	9	36	.80
4	5	6	11	36	.80
5	9	5	11	36	.90
6	15	7	17	36	.80
7	18	11	20	36	.80
8	7	15	25	36	.80
9	12	18	28	36	.80
10	1	18	30	36	.80
11	11	5	33	36	.70
12	2	3	20	36	.60
13	5	13	12	36	.60
14	15	5	10	36	.70
15	20	9	12	36	.60
16	22	18	17	36	.60
17	28	15	22	36	.60
18	36	24	26	36	.60
19	36	30	32	36	1.00
20	36	36	36	36	.50
21	36	36	36	36	.50
22	36	36	36	36	.50
23	36	36	36	36	.50
24	36	36	36	36	.50
25	6	36	36	36	.50
26	7	30	36	36	.50
27	12	9	36	36	.50
28	13	7	31	36	.50
29	25	15	32	36	.50
30	36	25	28	36	.70
31	1	30	31	36	.90
Aug. 1	1	7	27	36	.70
2	2	5	25	36	.80
3	6	3	16	36	.80
4	9	5	12	36	.80
5	7	8	10	36	.90
6	9	7	15	36	.90
7	1	10	17	36	1.00
8	1	4	20	36	.80
9	2	3	7	36	.70
10	5	4	8	36	.70
11	7	6	7	36	.60
12	15	8	7	24	.50
13	18	4	10	30	.50
14	18	10	12	36	.50
15	19	15	18	36	.50
16	15	24	25	36	.50
17	16	30	30	36	.50
18	11	30	33	36	.50
19	20	33	26	36	.50
20	22	28	36	36	.40
21	27	36	36	36	.40
22	30	36	36	36	.40
23	34	36	36	36	.40
24	36	36	36	36	.40
25	36	36	36	36	.40
26	36	36	36	36	.40
27	36	36	36	36	.40
28	36	36	36	36	.40
29	36	36	36	36	.40
30	36	36	36	36	.40
31	36	36	36	36	.40
Sept. 1	36	36	36	36	.40
2	12	36	36	36	.40
3	27	36	36	36	.40
4	9	36	36	36	.40
5	9	33	36	36	.50
Sept. 6	18	9	36	36	0.40
7	18	12	36	36	.50
8	28	20	34	36	.50
9	28	28	36	36	.40
10	4	36	36	36	.50
11	19	15	36	36	.40
12	30	14	36	36	.40
13	32	34	36	36	.40
14	35	28	36	36	.30
15	35	30	36	36	.30
16	36	36	36	36	.30
17	36	36	36	36	.30
18	36	36	36	36	.30
19	36	36	36	36	.30
20	36	36	36	36	.30
21	36	36	36	36	.30
22	36	36	36	36	.30
23	36	36	36	36	.40
24	36	36	36	36	.40
25	4	36	36	36	.50
26	1	28	36	36	1.00
27	1	5	36	36	.90
28	1	3	16	36	.90
29	11	1	8	36	.70
30	6	3	7	36	.60
Oct. 1	1	4	7	36	.80
2	2	4	7	36	.80
3	7	4	8	36	.70
4	9	4	9	36	.70
5	9	6	9	36	.70
6	1	7	10	36	1.20
7	1	4	10	36	1.00
8	5	4	9	36	.90
9	5	5	8	36	.80
10	11	6	9	36	.80
11	19	8	9	36	.70
12	1	10	9	36	1.20
13	1	6	17	36	1.50
14	1	4	13	36	1.10
15	2	3	8	36	.90
16	5	2	6	36	1.10
17	10	4	5	36	1.00
18	14	6	6	36	.90
19	19	8	6	36	.80
20	22	12	7	36	.80
21	26	15	10	36	.80
22	29	19	12	36	.70
23	32	20	20	36	.70
24	34	30	27	36	.70
25	34	36	36	36	.70
26	36	36	36	36	.70
27	36	36	36	36	.70
28	10	36	36	36	.90
29	5	36	36	36	1.30
30	2	10	36	36	.90
31	2	6	36	36	.80
Nov. 1	9	5	36	36	.70
2	16	4	22	36	.70
3	21	10	20	36	.70
4	23	16	21	36	.70
5	31	18	22	36	.70
6	33	24	22	36	.70
7	1	28	36	36	1.00
8	2	14	36	36	.80
9	3	4	17	36	.70
10	15	5	10	36	.70
11	20	7	9	36	.70

Condition of the water at Great Falls, Dalecarlia receiving, Georgetown distributing, and Washington City reservoirs, and height of water over the dam at Great Falls, etc.—Cont'd.

Day of month.	Condition of water.				Height of water over the dam at Great Falls (feet).
	Great Falls.	Dalecarlia receiving reservoir, south connection.	Georgetown distributing reservoir, effluent gatehouse.	Washington City reservoir, effluent.	
1902.					
Nov. 12	24	9	9	36	0.70
13	29	18	12	36	.60
14	32	36	20	36	.60
15	36	36	30	36	.60
16	36	36	30	36	.60
17	36	36	36	36	.60
18	36	36	36	36	.70
19	32	36	36	36	.80
20	31	36	36	36	.80
21	31	36	36	36	.70
22	36	36	36	36	.70
23	36	36	36	36	.70
24	36	36	36	36	.60
25	36	36	36	36	.60
26	4	36	36	36	1.20
27	3	30	36	36	1.30
28	1	18	36	36	1.40
29	1	12	36	36	.60
30	4	6	28	36	1.40
Dec. 1	1	4	25	36	.60
2	2	4	24	36	1.50
3	1	3	17	36	1.80
4	1	2	17	36	2.10
5	1	2	9	36	2.10
6	1	2	8	36	2.00
7	1	2	4	36	1.90
8	2	3	4	36	.80
9	4	5	4	36	1.80
10	6	8	4	36	1.80
11	10	8	6	32	1.60
12	12	10	5	25	1.60
13	7	12	3	20	1.80
14	1	15	8	19	2.60
15	1	10	9	22	2.50
16	1	4	9	20	2.30
17	1	5	7	21	2.90
18	1	4	6	20	2.20
19	1	3	5	25	2.90
20	2	4	4	36	2.40
21	2	3	3	24	2.20
22	1	4	3	22	2.30
23	1	6	4	19	2.30
24	1	4	4	17	2.20
25	2	4	3	16	1.90
26	6	6	4	17	1.80
27	12	8	5	19	1.60
28	14	10	6	21	1.60
29	21	12	7	17	.70
30	26	20	10	18	1.70
31	27	36	15	20	1.30
1903.					
Jan. 1	27	36	15	21	1.40
2	31	36	19	20	1.20
3	2	36	29	20	1.40
4	1	10	20	25	2.10
5	1	2	5	25	3.60
6	1	2	2	28	1.70
7	3	1	2	22	1.40
8	4	2	2	12	1.10
9	6	4	2	12	1.90
10	6	6	2	11	1.80
11	6	2	2	7	1.70
12	18	14	2	4	1.30
13	23	17	3	5	1.10
14	26	18	3	6	1.00
15	29	26	5	7	1.10
16	31	30	9	4	1.10
17	34	36	12	6	1.20
18	22	36	18	7	1.60
19	20	24	22	1	1.70

Day of month.	Condition af water.				Height of water over the dam at Great Falls (feet).
	Great Falls.	Dalecarlia receiving reservoir, south connection.	Georgetown distributing reservoir, effluent gatehouse.	Washington City reservoir, effluent.	
1903.					
Jan. 20	22	31	31	9	1.60
21	1	36	27	13	1.50
22	2	12	24	11	1.80
23	1	6	9	13	1.80
24	3	3	7	14	1.80
25	6	4	4	17	1.80
26	9	6	5	16	1.50
27	9	9	6	20	1.30
28	1	12	6	25	1.70
29	1	6	5	29	1.90
30	1	4	4	22	2.50
31	1	3	4	22	2.80
Feb. 1	2	2	3	32	2.70
2	4	4	3	32	2.30
3	7	2	3	36	2.10
4	11	4	3	27	2.10
5	1	6	3	22	2.80
6	1	2	3	21	3.00
7	1	2	2	23	3.00
8	2	2	2	20	2.30
9	6	2	1	18	2.10
10	10	3	2	10	2.00
11	10	5	2	20	1.50
12	4	7	3	6	1.70
14	1	8	3	5	1.70
15	5	2	4	4	1.60
16	6	3	3	4	1.60
17	1	6	3	4	1.10
18	1	4	3	4	2.70
19	1	4	4	4	2.30
20	7	6	4	3	1.10
21	12	8	4	4	1.70
22	15	10	5	5	1.60
23	18	12	6	6	1.50
24	20	15	8	7	1.60
25	16	24	9	8	1.70
26	19	24	12	8	1.70
27	13	18	12	11	1.80
28	1	20	18	9	1.10
Mar. 1	1	8	14	8	3.50
2	1	3	5	5	4.30
3	2	2	2	6	3.20
4	5	1	1	8	3.00
5	6	2	1	7	1.40
6	9	3	1	10	1.30
7	12	4	2	8	1.90
8	13	6	2	6	1.60
9	15	8	2	5	1.80
10	4	6	3	7	1.90
11	8	7	4	5	1.00
12	13	8	5	6	1.00
13	15	8	8	6	1.90
14	15	12	9	7	1.70
15	21	15	10	8	1.70
16	22	14	11	8	1.70
17	22	12	14	6	1.60
18	22	20	18	8	1.50
19	25	26	20	8	1.40
20	25	20	22	10	1.40
21	26	18	23	11	1.40
22	7	16	28	13	1.40
23	1	12	30	13	1.00
24	1	8	30	9	2.70
25	1	2	11	19	2.60
26	1	1	2	22	2.10
27	3	2	2	17	2.50
28	9	3	2	15	2.10
29	9	4	2	16	1.90
30	15	6	2	14	1.70
31	1	6	2	23	2.30
Apr. 1	1	4	3	28	2.30

Condition of the water at Great Falls, Dalecarlia receiving, Georgetown distributing, and Washington City reservoirs, and height of water over the dam at Great Falls, etc.—Cont'd.

Day of month.	Condition of water. Great Falls.	Condition of water. Dalecarlia receiving reservoir, south connection.	Condition of water. Georgetown distributing reservoir, effluent gatehouse.	Condition of water. Washington City reservoir, effluent.	Height of water over the dam at Great Falls (feet).
1903.					
Apr. 2	5	3	3	29	2.40
3	9	3	2	24	2.30
4	7	4	3	22	2.10
5	7	6	3	21	2.00
6	10	8	5	28	1.80
7	13	10	6	20	1.80
8	10	11	8	17	1.80
9	5	13	10	25	1.80
10	1	6	11	34	2.10
11	1	4	8	22	2.00
12	2	3	8	34	1.90
13	4	6	7	30	1.80
14	1	8	8	26	1.40
15	1	6	7	28	3.90
16	1	3	7	23	4.50
17	1	2	5	21	4.40
18	5	2	3	21	3.60
19	8	3	3	22	2.20
20	12	6	3	20	2.70
21	14	8	3	15	2.50
22	18	10	6	30	2.00
23	25	14	9	13	1.90
24	29	18	10	13	1.70
25	31	24	15	21	1.60
26	33	28	17	25	1.60
27	36	32	22	26	1.50
28	36	36	27	25	1.50
29	36	36	36	28	1.50
30	36	36	36	23	1.40
May 1	36	36	36	28	1.40
2	36	36	36	36	1.30
3	36	36	36	36	1.30
4	36	36	36	31	1.30
5	36	36	36	34	1.20
6	36	36	36	36	1.20
7	36	36	36	36	1.20
8	36	36	36	36	1.20
9	36	36	36	36	1.20
10	36	36	36	36	1.10
11	36	36	36	36	1.00
12	36	36	36	36	1.00
13	36	36	36	36	1.00
14	36	36	36	36	1.00
15	36	36	36	36	1.00
16	36	36	36	36	1.00
1903.					
May 17	36	36	36	36	1.00
18	36	36	36	36	.90
19	36	36	36	36	.90
20	36	36	36	36	.90
21	36	36	36	36	.90
22	36	36	36	36	.90
23	36	36	36	36	.90
24	36	36	36	36	1.00
25	36	36	36	36	.90
26	36	36	36	36	.90
27	36	36	36	36	1.00
28	36	36	36	36	1.00
29	19	36	36	36	1.10
30	6	24	30	36	1.10
31	1	10	28	36	1.30
June 1	1	6	31	36	1.20
2	1	2	16	36	1.40
3	1	2	5	36	1.60
4	6	3	2	36	.70
5	11	5	2	30	1.20
6	16	6	2	26	1.10
7	3	10	2	21	1.10
8	4	7	3	18	1.30
9	1	6	4	15	1.40
10	1	3	4	12	1.30
11	2	3	3	9	2.50
12	1	4	3	26	1.90
13	2	2	3	32	1.90
14	2	3	2	30	1.90
15	3	3	3	23	2.00
16	2	5	3	22	1.90
17	5	5	3	20	1.60
18	4	5	4	17	1.50
19	5	6	4	11	1.40
20	5	7	4	10	1.40
21	6	6	4	11	1.30
22	1	4	6	11	1.20
23	2	3	6	13	1.10
24	3	2	4	12	1.10
25	4	2	3	11	1.10
26	4	4	3	19	1.50
27	4	6	3	26	1.40
28	9	6	5	23	1.30
29	1	8	6	25	3.60
30	1	9	8	26	3.60

According to the scale for recording the condition of the water as regards clearness, the numbers 0 to 7, inclusive, correspond to very turbid; 8 to 14, turbid; 15 to 21, slightly turbid; and 22 to 36, clear. The following table shows the condition of the water at various parts of the system during the year:

Condition.	Number of days when this condition existed at— Great Falls.	Dalecarlia reservoir, effluent.	Georgetown distributing reservoir, effluent.	Washington City reservoir, effluent.
Very turbid	165	145	146	33
Turbid	46	70	48	38
Slightly turbid	36	28	29	41
Clear	118	122	142	253
Total	365	365	365	365

Daily gauge pressures at the office of the Washington Aqueduct at 9 o'clock a. m.

Month.	Main.	1.	2.	3.	4.	5.	6.	7.	8	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Average.
1902.	*Inch.*																																
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
July	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	41	41	41	41	40	40	40	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	39	40	40	40	41	40	40	41	40.68
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
August	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	40	40	41	40	41	40	40	40	40	40	40	41	40	40	40	40	40	41	41	40	40	40	40	40	40	40	40	40	40	40	40	40.16
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	....	30
September	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	40	40	41	40	40	40	40	40	40	40	41	41	40	40	40	41	41	40	40	40	40	41	41	41	40	40	40	40	41	41	....	40.33
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
October	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	41	41	41	41	41	41	41	41	40	41	40	40	41	40	40	40	41	40	41	41	41	39	40	40	41	41	41	41	41	40	40	40.58
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	....	30
November	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	40	40	40	40	40	40	40	41	41	40	40	40	41	41	41	41	41	40	40	41	41	40	40	40	41	41	41	41	41	41	....	40.50
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
December	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	40	41	41	41	40	41	41	41	40	41	37	39	40	40	40	41	41	41	40	41	41	41	41	41	40	40	40	40	40	40	40	40.35
1903.																																	
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
January	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	39	40	40	40	39.97
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	....	....	....	30
February	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	....	....	31
	48	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	39	40	....	....	....	39.96
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
March	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	41	40	40	40	41	41	41	41	40	40	40	41	41	41	41	39	40.25
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	....	30
April	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	....	31
	48	40	40	41	41	41	41	40	40	40	41	41	41	40	40	40	41	40	40	40	40	40	40	40	40	41	41	41	41	40	41	....	40.43
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
May	36	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
	48	39	40	40	40	40	41	40	40	40	41	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40.03
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	....	30
June	36	31	31	38	38	38	38	38	36	37	39	38	38	38	37	38	35	35	38	37	35	35	35	35	36	36	36	37	37	38	38	....	36.53
	48	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	41	40	40	40	40	38	40	40	40	40	....	39.96

D D D 2.

INCREASING THE WATER SUPPLY OF WASHINGTON, DISTRICT OF COLUMBIA.

This work has been prosecuted under acts making appropriations to provide for the expenses of the government of the District of Columbia. The act approved June 30, 1898, authorized and directed the Secretary of War to resume work on the Washington Aqueduct tunnel and its accessories and the Howard University reservoir, in accordance with the plans of the board of experts as set forth in its report, dated January 17, 1896, and the work has been done in accordance with those plans.

The work accomplished during the year was as follows:

At the west-shaft gatehouse.—A building, 27 by 28 feet and similar in design to the west-shaft gatehouse, was constructed over the shaft. The superstructure was covered with Portland-cement plaster, blocked off to represent stonework. A hoisting engine and crane were set up in this house for use in cleaning out the tunnel. The grounds around the house were graded and sodded, walks and steps constructed, and a fence erected. The old sheds used in constructing the shaft and buildings were removed.

At Foundry Branch shaft.—All the surplus boilers, engines, cars, rails, etc., used in the construction of the tunnel and Washington City reservoir were hauled to this shaft and stored in sheds which had been used during the construction of the tunnel.

At Rock Creek shaft.—The painting and placing of window sash, doors, and drains completed the work on the power house, with the exception of a small amount of the concrete flooring, in which the railing around the top of the pump is to be placed.

The contractors who installed the centrifugal pumping plant at this shaft having reported that the plant was completed and ready for testing, the tunnel was partially emptied through the blow-out on September 24, 1902, and a trial of the pumps made on the following day. The plant failed on this test on account of the breaking of the cut-off valve stem on engine No. 2. The necessary repairs were effected and three further tests were made during the following month, the test failing each time owing to breaks or bends in the valve stems of the engines. During the winter the engines were overhauled and entirely new valves of a different kind were put in by the contractors. On April 17, 1903, a final test was made, which proved satisfactory, and the plant was accepted.

A hoisting engine and crane were erected in the power house and so placed as to be used for handling materials in either shaft or pump pit. All the old sheds used in the tunnel construction were removed, the grounds graded, a large water tank erected, and a nine-room frame dwelling house built for the use of the watchman in charge of this blow-off and pumping station.

At Champlain avenue shaft.—The cleaning, painting, placing of concrete floor, window sash, doors, and drains completed the work on the power house. A hoisting engine and crane were erected for handling materials and cleaning out the tunnel at this shaft. All the sheds used in the tunnel construction were removed, the grounds around the power house were graded and sodded, walks and drives were constructed, and

a fence erected around the grounds. The ground between Eighteenth street and the fence around the power house, which is intended to be used as a public park, was graded and sodded. Concrete walks and a fountain were constructed.

At the Washington City reservoir.—The cleaning, painting, plastering, placing stairway, window sash, doors, and drains, completing roof and valve chambers, and erecting hoisting engine and crane finished the work on the east shaft gatehouse. The grounds around the gatehouse and the power house were graded and sodded, the roads from Fourth street to the dam, Fourth street to the power house, and on the west side of the gatehouse were completed. Walks, gutters, and drains were completed around the gatehouse, the power house, and along the roads. A nine-room dwelling house for the principal watchman was constructed on the hill at the north end of the reservoir, and the old house of the second watchman was repaired. The top of the revetment on the west side of the reservoir was brought up to grade, and small repairs were made to the revetment on the east side of the reservoir.

A strip about 5 feet wide along the edge of the reservoir was graded for the iron fence. The fence, which is being erected by contract, has been nearly completed, about 6,600 of the 6,692 feet contracted for having been erected. Half of the fence has been painted with the second coat of paint. The sodding of the 3-foot strip between the fence and top of the reservoir embankment has been completed for about one-third of the distance around the reservoir.

On September 3, 1902, the construction of the superstructure over the stop-plank chamber, at the end of the circulating conduit, was begun, and the building was completed during the following month. It is of red brick with red tile roof, and is uniform in style with the other buildings of the aqueduct system near the Washington City reservoir. The building was constructed by day labor throughout. The site being in the reservoir, about 250 feet from the nearest point of the shore, a flatboat was built and the materials conveyed from the shore to the site of the building as needed. This flatboat was also used in the construction of the superstructure over the Congressional spring house, which was erected immediately after the completion of the gatehouse over the end of the circulating conduit. The building is circular in plan, and as it was not deemed advantageous to have special tile made for the roof it was roofed with copper. The walls are of red brick. All the work was done by day labor except the copper covering of the roof, which was put on after advertising by circular letters.

The six lengths of 75-inch main were removed from near the east shaft gatehouse and stored on the United States ground near Fourth and Lincoln streets. All sheds, derricks, etc., used in the tunnel and reservoir construction were removed.

The work which has been prosecuted under the heading "Increasing the water supply of Washington, D. C.," has been completed with the exception of a small amount of work on the iron fence around the reservoir. No further estimate for this work is submitted, the pay of the necessary watchmen and gatekeepers being included in the regular Washington Aqueduct estimates.

Money statements.

GENERAL IMPROVEMENT.

July 1, 1902, balance unexpended	$20,023.48
Amount appropriated by act approved July 1, 1902	40,240.00
Amount appropriated by deficiency act approved July 1, 1902	2,250.00
	62,513.48
June 30, 1903, amount expended during fiscal year	61,138.39
July 1, 1903, balance unexpended	1,375.09
July 1, 1903, outstanding liabilities	365.62
July 1, 1903, balance available	1,009.47

IRON FENCE AROUND RESERVOIR.

Amount appropriated by act approved July 1, 1902	$27,000.00
June 30, 1903, amount expended during fiscal year	9,432.59
July 1, 1903, balance unexpended	17,567.41
July 1, 1903, outstanding liabilities	1,954.54
July 1, 1903, balance available	15,612.87
July 1, 1903, amount covered by uncompleted contracts	8,739.45
Amount (estimated) required for completion of existing project	1,200.00

The following are the amounts and dates of appropriations for the work:

July 15, 1882	$1,485,279.30	March 3, 1899	$200,000.00
July 7, 1884	87,500.00	June 6, 1900	139,034.34
March 3, 1885	87,500.00	March 1, 1901	162,222.97
March 26, 1886	5,000.00	July 1, 1902	67,240.00
August 4, 1886	555,000.00		
March 30, 1888	355,000.00	Total	3,440,987.11
June 30, 1898	[a]297,210.50		

ABSTRACT OF CONTRACTS IN FORCE JUNE 30, 1903.

Name: A. F. Jorss, Washington, D. C., for iron fence around reservoir.
Rate: $2.49.
Date of approval: Emergency contract.
Date of beginning work: Five days.
Date of expiration: Six months; extended four months.

[a] The total amount appropriated by this act was $594,421, one-half of which was a reappropriation of balances remaining from former appropriations.

Distribution of expenses Washington Aqueduct tunnel and Washington City reservoir.

Items.	Year ending June 30, 1899.		Year ending June 30, 1900.		Year ending June 30, 1901.		Year ending June 30, 1902.		Year ending June 30, 1903.		Total.
	Labor.	Materials.	Labor.	Materials.	Labor.	Materials.	Labor.	Materials.	Labor.	Materials.	Labor and materials.
Revetment of reservoir banks			$11,665.55	$8,661.51	$1,415.37	$93.55	$2,850.51	$2,704.44			$27,390.93
Cleaning bottom of reservoir			894.27		7,015.46	69.27	1,411.32				9,390.32
Congressional spring house					136.16	196.04	130.00		$97.57	$50.06	609.83
Drainpipe chamber					217.99	269.81					487.80
Circulating conduit			257.30	16.55	14,958.33	20,398.07					35,630.25
Face wall					1,576.38	1,535.56					3,111.94
East power house					1,197.83	2,722.37	2,100.88	2,142.23	226.75	177.49	8,567.55
East shaft gatehouse			1,177.79	2,376.22	18,553.66	78,759.36	11,599.91	13,575.77	2,173.13	10,860.82	139,076.66
75-inch main			273.87	46.94	423.25	1,983.20	468.80	1,054.75			4,250.81
Filling around gatehouse			133.93		4,905.26	3.13	2,939.34				7,972.66
Air shafts (3)			1,590.48	869.17			24.40	9.20			2,491.25
Pumping plants				185.69							185.69
Champlain avenue power house					1,201.54	1,888.06	2,886.34	3,840.75	1,287.83	292.35	11,396.87
Miscellaneous, watchmen, etc			1,058.00		720.00		2,310.56	49.06			4,137.62
Machinery and plant						2,391.67	148.00	765.40			3,305.07
Engineering and office expenses			2,486.72		4,817.90		9,354 73	491.87			17,151.22
Intake system from filtration plant, filter gatehouse					1,556.10	1,618.16			64.88		3,239.14
Tools, machinery, and repairs	$603.00	$7,006.71		3,306.04	721.52	2,452.00				1,304.74	15,394.01
Erecting and maintaining buildings	1,334.00	1,596.61	31.00	67.99							3,029.60
Repairing road to Rock Creek	427.00	396.50	665.00	219.94	300.18						2,008.62
Retimbering shafts, building head houses	3,865.00	3,308.76	114.00	17.60							7,305.36
Building and repairing cars	340.00	1,703.28	360.00	213.90							2,617.18
Experimental arch at Rock Creek	117.00	233.50									350.50
Erecting gas plant and lighting work	644.00	6,602.78	536.00	4,008.32	280.00	899.73	120.00	78.50			13,169.33
First pumping out of tunnel	1,388.00	545.90									1,933.90
Pumping out tunnel during construction	6,470.00	1,903.58	6,328.00	315.15	4,900.00	369.06	1,320.00	1,102.03			22,707.82
Trimming tunnel for lining	13,508.00	1,076.89									14,584.89
Excavating and track laying	21,570.00	5,077.51	7,721.00	374.01							34,742.52
Cutting drainage channels from Foundry Branch to Rock Creek:											
Trimming	13,094.00	627.70	7,076.00	370.91							34,132.72
Excavating	12,674.00	290.11									
Cleaning grounds at Foundry Branch							958.72	6.38			965.10
Air-lift pumping plants							124.38	60,268.26			60,392.64
Cleaning out toothing in old brickwork	326.00	290.11									616.11
Cleaning snow and ice from roads	138.00	38.50									176.50
Hauling coal during blizzard	63.00										63.00
Taking out rail left by contractors	24.00	162.61									186.61
Making centers for brickwork	143.00	669.26									812.26
Building brick lining and rubble backing	12,097.00	9,657.88	27,779.00	36,034.25	18,722.12	20,983.91					125,274.16
Concrete under invert	2,823.00	1,984.29	13,700.00	8,390.96	854.24	361.33					28,113.82

Repairing old arch with rubble backing and closing holes in arch	4,832.00	2,820.80	38,614.89	14,895.15	1,089.50	285.29					62,637.63
Placing iron lining under Rock Creek	1,522.00	4,312.18	7,497.00	17,639.28							31,978.46
Iron on hand not laid		1,008.00									
Grouting in tunnel			24,375.00	24,843.60	5,825.04	3,943.20					58,986.84
Grouting in west shaft			404.00	948.96							1,352.96
Grouting and relining east shaft			1,975.00	1,244.28	2,609.14	2,039.20	254.68	401.18			8,523.48
Underpinning old side walls			551.00	294.35							845.35
Excavating sand at Rock Creek			364.00								364.00
Invert and sump at west shaft			816.00	197.25							1,013.25
Crushing stone for invert			1,929.85	189.46							2,119.31
Plastering old stone side walls			1,961.00	453.92	1,176.05	300.00					3,890.97
Cement washing west shaft			40.00	5.40							45.40
Cement washing tunnel			1,244.00	455.35	3,236.24	387.52					5,223.11
Engineering, office expenses, superintending, etc	7,922.43		11,579.28		8,651.91	1,235.36			7,434.91		36,823.89
Grading grounds at Rock Creek					994.38		864.79		424.87		2,284.04
Excavating and cleaning tunnel					5,076.00	196.73	707.36				5,980.09
Closing Foundry Branch shaft					1,040.63	875.92					1,916.55
Closing Rock Creek shaft					3,785.85	8,586.32	2,220.70	1,073.13			15,666.00
Constructing Rock Creek pump pit					5,458.39	3,277.49	1,946.73	520.60			11,203.21
Constructing Rock Creek power house					3,333.75	1,398.24	3,169.48	6,654.68	1,517.09	371.80	16,445.04
Closing Champlain avenue shaft					2,285.67	4,668.96	2,831.34	1,818.85			11,604.82
Constructing west shaft gatehouse			3,887.25	22,498.94	10,405.15	20,157.50	7,128.92	2,583.67			66,661.43
Light pipe line						4,362.07	29,555.66	20,452.12			54,369.85
Heavy pipe line across reservoir					7,200.32	48,007.44					55,207.76
Grading, sodding, and building roads, Washington City reservoir									8,483.95	362.30	8,846.25
House over mouth of circulating conduit									328.89	122.40	451.29
Watchman's house, Washington City reservoir									2,436.94	2,053.86	4,490.80
Repairing old house, Washington City reservoir									672.75	417.65	1,090.40
Iron fence, Washington City reservoir									1,934.21	7,498.38	9,432.59
Removing and storing old machinery									721.51	73.57	795.08
Grading and fencing Champlain avenue									1,629.46	286.55	1,916.01
Rock Creek pumping plant									18.50	10,072.50	10,091.00
Watchman's home, Rock Creek									2,114.15	1,911.58	4,025.73
House over west shaft									2,002.45	863.42	2,865.87
Fencing grounds at west shaft										126.55	126.55
Total expenditures as per vouchers.	136,290.60		316,788.67		357,603.53		265,002.41		70,415.86		1,146,256.19
Outstanding liabilities July 1, 1902							155.12				
											1,146,256.19

Table showing amount of work performed.

Class of work.	Year ending June 30, 1899.	Year ending June 30, 1900.	Year ending June 30, 1901.	Year ending June 30, 1902.	Year ending June 30, 1903.	Total.
Revetment of reservoir banks:						
Completed paving ..... square yards..	....	12,406.38	288	2,990	....	15,684.38
Additional broken-stone layer..do....	....	22.52	266	....	....	288.52
Old paving torn up............do....	....	6,084.1	....	....	....	6,084.1
Excavation for grading..cubic yards..	....	16,651.5	1,550	1,779	....	19,980.5
Cleaning bottom: Excavation....do....	....	2,929	11,194	409	....	14,532
Congressional spring house: Concrete, cubic yards	....	....	22	....	....	22
Drainpipe chamber:						
Excavation ....cubic yards..	....	....	12	....	....	12
Concrete ....do....	....	....	45.7	....	....	45.7
Circulating conduit:						
Excavation....................do....	....	....	3,541	....	....	3,541
Portland concrete.............do....	....	....	2,750.9	....	....	2,750.9
Natural concrete ....do....	....	....	916	....	....	916
Plastering..............square yards..	....	....	8,752	....	....	8,752
Back filling ....cubic yards..	....	....	1,259	....	....	1,259
Face wall:						
Excavation....................do....	....	....	1,674	....	....	1,674
Portland concrete.............do....	....	....	387.2	....	....	387.2
East power house:						
Excavation ....do....	....	....	959	....	....	959
Portland concrete.............do....	....	....	189	16	....	205
Brickwork ....do....	....	....	39	71	....	110
East shaft gatehouse:						
Excavation....................do....	....	3,512.5	9,997.5	....	....	13,510
Portland concrete.............do....	....	....	3,733	528	5	4,266
Cut stone.....................do....	....	....	917.9	279	....	1,196.9
Brickwork ....do....	....	....	....	574	9	583
75-inch main: Excavation ....do....	....	699	....	....	....	699
Filling around gatehouse:						
Excavation for puddle core ....do....	....	....	1,722	956	....	2,678
Excavation for embankment ..do....	....	193	2,074	....	....	2,267
Puddle placed.................do....	....	....	2,804	948	....	3,752
Embankment material placed .do....	....	....	11,207	2,741	....	13,948
Excavating grounds around the gatehouse ....cubic yards..	....	....	....	3,548	....	3,548
Air shafts:						
Fayette street...................feet..	....	156	....	....	....	156
Widow's Mite ....do....	....	152.33	....	....	....	152.33
Thirteenth street..............do....	....	128.25	....	....	....	128.25
Champlain avenue power house:						
Clearing muck from site.cubic yards..	....	....	1,000	....	....	1,000
Excavation....................do....	....	....	344	....	....	344
Portland concrete.............do....	....	....	166	88	33	287
Brickwork ....do....	....	....	5	100	9	114
Tunnel:						
Trimming.................linear feet..	5,919	....	176	....	....	6,095
Track laid....................do....	20,594	....	....	....	....	20,594
Material removed........cubic yards..	29,678	8,578	800	....	....	39,056
Timber removed from back of arch, cords	54	173	....	....	....	238
Brick laid....................number..	784,712	1,810,167	1,302,355	....	....	3,897,234
New invert lined.................feet..	1,465	3,557	825	....	....	5,847
New arch lined ....do....	784	2,532	2,435	....	....	5,748
New side wall lined............do....	1,435	3,167	727	....	....	5,329
Relining Howard shaft ....do....	....	....	128	....	....	128
Brick laid in Howard shaft.number..	....	....	80,500	....	....	80,500
New invert placed in old lining..feet..	442	5,841	860	....	....	7,143
Old lining repaired with rubble masonry.........................feet..	446	14,091	....	....	....	14,537
Concrete in place ....cubic yards..	943	3,926	80	....	....	4,949
Masonry backing for old arch..do....	1,573	9,174	....	....	....	10,747
Masonry backing for new arch..do....	1,236	2,814	11,581	....	....	15,631
Iron lining for tunnel at Rock Creek, feet	100	400	24	....	....	524
Stone side walls plastered.linear feet..	....	3,840	1,494	....	....	5,334
Stone crushed...........cubic yards..	900	4,634	5,142	....	....	10,676
Drainage changed from Foundry Branch to Rock Creek..linear feet..	2,812	615	....	....	....	3,127
Old arch grouted...............do....	....	11,911	2,250	....	....	14,161
Old arch grouted, cement used, barrels	....	24,248	3,835	....	....	28,083
Grouting west shaft, cement used, barrels	....	708	....	....	....	708
Grouting east shaft, cement used, barrels	....	1,144	....	....	....	1,144
Cement washing tunnel (two coats), linear feet	....	6,255	13,901	....	....	20,156
Sand taken out of Rock Creek, cubic yards	....	577	....	....	....	577

Table showing amount of work performed—Continued.

Class of work.	Year ending June 30, 1899.	Year ending June 30, 1900.	Year ending June 30, 1901.	Year ending June 30, 1902.	Year ending June 30, 1903.	Total.
Tunnel—Continued.						
Concrete placed at west shaft gatehouse ....cubic yards..	....	669	640	291	....	1,400
Rubble masonry placed at west shaft gatehouse ....cubic yards..	....	....	25	....	....	25
Cut stone laid at west shaft gatehouse, cubic yards	....	....	540.6	14	....	554.6
Brick laid at west shaft gatehouse, number	....	1,900	234,350	3,725	....	239,975
Excavation at west shaft gatehouse, cubic yards	....	4,132	449	914	....	5,495
Concrete placed in closing Foundry Branch shaft ....cubic yards..	....	....	189	....	....	189
Brick laid in closing Foundry Branch shaft ....number..	....	....	37,050	....	....	37,050
Earth placed in closing Foundry Branch shaft ....cubic yards..	....	....	....	260	....	260
Concrete placed closing Rock Creek shaft ....cubic yards..	....	....	453	255	....	708
Iron lining placed closing Rock Creek shaft ....feet..	....	....	42	4	....	46
Excavation for pump pit at Rock Creek shaft ....cubic yards..	....	....	1,552	....	....	1,552
Rubble masonry placed in pump pit at Rock Creek shaft...cubic yards..	....	....	16	....	....	16
Concrete placed in pump pit at Rock Creek shaft ....cubic yards..	....	....	391	....	....	391
Brick laid in pump pit at Rock Creek shaft ....number..	....	....	76,350	6,500	....	82,850
Concrete placed in power-house foundation at Rock Creek shaft, cubic yards	....	....	613	86	40	739
Brick laid in power house at Rock Creek shaft ....number..	....	....	....	110,300	9,850	120,150
Concrete placed in closing Champlain avenue shaft ....cubic yards..	....	....	278	209	....	487
Brick laid in closing Champlain avenue shaft ....number..	....	....	41,650	8,600	....	50,250
New reservoir:						
48-inch pipe laid across reservoir, number	....	....	502	31	....	533
Excavation for pipe lines across reservoir ....cubic yards..	....	....	4,276	....	....	4,276
Filling excavation for pipe lines across reservoir ....cubic yards..	....	....	1,131	2,338	....	3,469
48-inch pipe laid through dam for city supply ....number..	....	....	2	202	....	204
Excavation for pipe lines through dam ....cubic yards..	....	....	....	43,230	....	43,230
House over west shaft:						
Concrete ....cubic yards..	....	....	....	....	89	89
Brick masonry ....do....	....	....	....	....	81	81
Excavation ....do....	....	....	....	....	773	773
Watchman's house, Rock Creek:						
Concrete ....cubic yards..	....	....	....	....	12	12
Rubble masonry ....do....	....	....	....	....	33	33
Watchman's house, Washington City reservoir:						
Concrete ....cubic yards..	....	....	....	....	15	15
Rubble masonry ....do....	....	....	....	....	30	30
Excavation and grading grounds, roads, ditches, etc.....cubic yards..	....	....	....	....	12,443	12,443
Filling for roads, gravel ....do....	....	....	....	....	1,431	1,431
Sodding ....square yards..	....	....	....	....	10,940	10,940
Iron fence erected ....feet..	....	....	....	....	6,600	6,600

D D D 3.

WASHINGTON AQUEDUCT, DISTRICT OF COLUMBIA, FILTRATION PLANT.

By acts approved June 30, 1898, and March 3, 1899, the sum of $8,000 was appropriated for "investigating the feasibility and propriety of filtering the water supply of Washington." This investiga-

tion was conducted and a report thereon submitted to Congress on March 28, 1900.

In this report it was recommended that for the filtration of the Potomac water, as delivered for the Washington water supply, the American or rapid sand filtration be adopted. This method involves the application of a coagulant—sulphate of alumina—to the raw water.

By act approved June 6, 1900, an appropriation of $200,000 was made "for establishing those portions of a filtration plant which are essential to the operation of either system of filtration adopted, including necessary land, grading, masonry, and appurtenances."

A project for the expenditure of this appropriation was submitted and was approved August 15, 1900. The project consisted of the purchase of land sufficient for the erection of the plant and a clear-water basin, in case the American system were adopted, the estimate for land alone for the slow sand system being more than $550,000.

During the second session of the Fifty-sixth Congress the subject of filtration was before the Senate Committee on the District of Columbia, and an examination of experts on the subject of filtration was held in New York City. The subject was also taken up by the subcommittee on the District of Columbia of the House Committee on Appropriations. At the examination of experts by the Senate committee and the hearing before the House subcommittee a strong opposition to the use of any chemical as a coagulant in any process of filtration of the Washington water supply was manifested by the resolutions of the Washington Board of Trade, the Washington Business Men's Association, and the Medical Society of the District of Columbia. This manifest opposition by the future consumers of proposed filtered water had the desired effect, and Congress, complying with the expressed desire of the citizens of the District, as manifested by the above organizations, by act approved March 1, 1901, appropriated $500,000 "toward establishing a slow sand filtration plant, and for each and every purpose connected therewith, including the preparation of plans, and for the purchase of such scientific books and periodicals as may be approved by the Secretary of War, to be available immediately and until expended."

The evident and manifest intention of Congress has thus been declared to be in favor of the establishing of a slow sand filtration plant for the Washington water supply, in contradistinction to any system of filtration which may require the use of any chemical as a coagulant.

The site for the filtration plant as recommended by the report from this office was on ground situated on either side of First street NW., in the immediate vicinity of the Washington City reservoir, and adjacent to the grounds of the Soldiers' Home. Some controversy or difference of opinion as to the location of a site for the plant arose, but it was finally decided to locate the plant as at first recommended, and to purchase enough land to provide for the filtration of the total daily capacity of the Washington Aqueduct, or 75,000,000 gallons per diem.

On September 29, 1900, from the appropriation of $200,000, act of June 6, 1900, the block bounded by First street, Detroit street, Emporia street, and the lands of the United States, containing 169,772 square feet, was purchased from Stellwagen and Edmonston, trustees, at a cost of 45 cents per square foot, or a total of $76,397.40. It was proposed to expend the remainder of the appropriation, or as much as was necessary, in the construction of a gatehouse and clear-water

basin, with the necessary gates, valves, and connections, and an intake for pumping the water to the filter beds.

When, by act of March 1, 1901, Congress decided that the slow sand system should be adopted by appropriating $500,000 more toward filtration, all plans were adapted to this system, and an additional purchase of land was made, being enough to serve for a slow sand filtration plant with a capacity of 75,000,000 gallons per diem.

The land purchased consisted of lots 2 to 13, inclusive, in block 26 and all of blocks 29 and 30 in Stellwagen and Edmonston's addition to Le Droit Park, and squares 13, 14, 15, 16, and 39 in Dobbins's addition to the city of Washington, D. C., being in all 1,207,847 square feet, at 45 cents, thus requiring $543,531.15. This left available, less outstanding liabilities, a sum of about $30,000, which it was deemed would be required to complete the gatehouse and its connections and the intake for the pumps. It was deemed wisest to expend this balance for this purpose, in order that the Washington City reservoir should be utilized in connection with the tunnel for increasing the water supply of Washington as soon as finished, without waiting for the completion of the filtration plant.

OPERATIONS DURING THE YEAR.

Intake gatehouse.—This building, the foundations for which had already been constructed, as had also the foundations for the filtration gatehouse, is of red brick with red tile roof. It was built by day labor with the exception of the copper guttering and downspouts, which were put in after advertising by circular letters. It was constructed during October and November, 1902. In this building and in the house over the end of the conduit artificial stone was used for the window sills, but it has not proved altogether satisfactory, as fine cracks have developed in it, and in the filtration gatehouse now under construction natural Maynard sandstone is being used for the sills.

Filtration gatehouse.—Work on this building, which is of the same style as the intake gatehouse, was begun June 9, 1903, and at the end of the year the walls had been completed up to the cornice. This building will be erected by day labor with the exception of the copper guttering and downspouts, which will be put in after advertising by circular letters.

General plans.—On July 12, 1902, advertisement was made calling for proposals for the different classes of work to be done on the filtration plant. On August 5, 1902, by direction of the Chief of Engineers, United States Army, the advertisement and specifications were recalled "In order to take advantage of the most recent improvements in the construction and operation of filters, and to avoid the possibility of subsequent modifications of contracts." With the approval of the Secretary of War, Mr. Allen Hazen was employed as consulting expert to supervise the preparation of a new set of plans and specifications. Advertisements under the new plans were issued on December 29, 1902, and the bids opened January 28, 1903. The amount of the bids under these proposals exceeded the amount allowed by law for the expenditure for the plant. By authority of the Chief of Engineers, United States Army, all bids except those for American Portland cement were rejected, and on February 5, 1903, new advertisements were issued for proposals to be opened February 20, 1903. The bids under these proposals again

exceeded the amount authorized, and the matter was laid before Congress with the recommendation that the amount authorized be increased by $700,000 or to $3,468,405. By act approved March 3, 1903, this was done and new plans were advertised on March 19, 1903, and opened March 31, 1903, authority to accept the bid of the Virginia Portland Cement Company for "Old Dominion" brand of American Portland cement, under their bid opened January 28, 1903, being given by the Chief of Engineers, U. S. Army, on March 19, 1903. Under the proposals opened March 31, 1903, contracts were entered into with Cowardin, Bradley, Clay & Co., Richmond, Va., for excavation, embankment, and concrete work; with the Brennan Construction Company, Washington, D. C., for furnishing and placing pipe and for the exterior and interior drainage system, and with L. E. Smoot, Washington, D. C., for filter sand and gravel.

On April 22, 1903, bids were advertised, to be opened May 22, 1903, for furnishing materials not previously contracted for, and contracts awarded as follows:

Venturi meters, to Builders' Iron Foundry, Providence, R. I.
Sluice gates and gate valves, to Coffin Valve Company, Boston, Mass.
Special castings, to Wilkinson Manufacturing Company, Bridgeport, Pa.
Pumping engines, to Henry R. Worthington, New York, N. Y.
Boilers, stokers, and economizers, to Babcock & Wilcox Company, New York, N.Y.

These contracts were entered into during the month of June, 1903, and at the close of the fiscal year were awaiting the approval of the Chief of Engineers, United States Army.

Work of contractors.—The contractors, Cowardin, Bradley, Clay & Co., began the work of excavation with a small force of wheeled scrapers on May 4, 1903. The work done by them up to the end of the year consisted in partially clearing the trees from the site of the filtration plant, excavating 24,600 cubic yards of earth, and beginning the installation of the plant. The work has not progressed as rapidly as desired owing to rainy weather and the delay in securing and installing the plant. At present the plant is being rapidly put in, and it is believed that satisfactory progress will soon be made.

The contractor's plant on the ground at the end of the year at work, or ready for work, consisted of—

One 30-ton steam shovel (1¼ yard dipper).
Two locomotives.
Forty dump cars (4½ yards).
One steam roller, 10 tons.
One "New Era" grading machine.
One traction engine.
Thirty-six dump wagons.
Fifty-three wheeled scrapers.
Six plows.
One hundred and seven mules.
Standard-gauge railroad track, blacksmith shop, stables, office, tool sheds, etc.

The contractors have also rented a portable sawmill and are making lumber of the trees removed from the site. In addition to the above, there are on the ground or approaching one 50-ton and one 60-ton steam shovel and two locomotives. This plant will soon be at work, and other locomotives, cars, concrete-mixing machinery, cableways, etc., have been ordered.

Surveying.—On March 1, 1903, a small survey party started to work laying out the lines along which the contractors are to work. They have since been continuously employed laying out lines and grades

and making surveys for monthly estimates. When not needed for field work they have been employed in making computations of work done or to be done.

Field office.—During the month of April a 5-room wooden building was erected on the top of the hill just south of the site of the clear-water reservoir. This building was occupied on May 22 as a field office for the construction of the filtration plant, one room being set aside to be fitted up as a cement-testing laboratory. The apparatus for cement testing has already been obtained.

Preliminary treatment of Potomac water.—On January 12, 1903, there was referred to this Office from the Office of the Chief of Engineers, United States Army, an amendment, intended to be proposed by Mr. Dillingham to the bill making appropriations for the expenses of the government of the District of Columbia for the fiscal year ending June 30, 1904, and for other purposes, providing for works for the preliminary treatment of the Potomac water above the Georgetown distributing reservoir and for improvements to the same.

On February 26, 1903, a report on this subject was made to the Chief of Engineers, United States Army, a copy of which is appended hereto marked Appendix A.

Estimate.—The act of Congress approved March 3, 1903, making appropriations for the expenses of the government of the District of Columbia for the fiscal year 1904 appropriated $600,000 for continuing this work and raised the limit of expenditure from $2,768,405 to $3,468,405, with the proviso that the work should be finished by December 1, 1904. The following table shows that if the work is to be completed as specified by Congress an appropriation of $1,568,155 will be required for the fiscal year 1905, and a recommendation to that effect is made.

Amount authorized by Congress	$3,468,405.00
Amount expended to June 30, 1903	729,611.45
Balance authorized to be expended	2,738,793.55
In Treasury United States	1,170,638.55
Amount to be appropriated	1,568,155.00

Money statement.

July 1, 1902, balance unexpended	$62.25
Amount appropriated by deficiency act approved July 1, 1902	250.00
Amount appropriated by act approved March 3, 1903	600,000.00
Amount appropriated by act approved July 1, 1902	600,000.00
	1,200,312.25
June 30, 1903, amount expended during fiscal year	29,673.70
July 1, 1903, balance unexpended	1,170,638.55
Amount authorized, but unappropriated	1,568,155.00
	2,738,793.55
July 1, 1903, outstanding liabilities	4,851.54
July 1, 1903, balance available	2,733,942.01
July 1, 1903, amount covered by uncompleted contracts	1,952,399.00
Amount (estimated) required for completion of existing project	2,738,793.55
Amount that can be profitably expended in fiscal year ending June 30, 1905, in addition to the balance unexpended July 1, 1903	1,568,155.00

The amounts expended on the several items of the filtration plant, by fiscal years, are as follows:

Distribution of expenses.

Items.	Year ending June 30, 1901.		Year ending June 30, 1902.		Year ending June 30, 1903.		Total labor and materials.
	Labor.	Materials.	Labor.	Materials.	Labor.	Materials.	
Plant and tools	$201.60	$1,752.71	$14.00	$78.89			$2,047.20
Clear-water reservoir	10,630.06	537.80	5,254.47	3,523.86			19,946.19
Gatehouse	2,381.66	11,658.02	699.34	608.94	$818.00	$251.85	16,417.81
Pipe line between gatehouse and clear-water reservoir	1,226.72	1,677.48	1,380.28	1,778.23			6,062.71
Intake	16.87		1,924.55	7,184.89	835.51	879.16	10,840.98
Survey	139.01		919.93	10.95			1,069.89
Washington City reservoir			570.64				570.64
General plans	2,714.47		6,302.93	383.05	16,251.21	802.97	26,454.63
Land		619,937.30					619,937.30
Pipe line between gatehouse and east shaft gatehouse	813.78	12,582.12		3,033.20			16,429.10
Surveying					1,342.50	13.29	1,355.79
Field office and fixtures					571.57	421.07	992.64
Watching property					343.50		343.50
Miscellaneous expenditures					72.00	211.30	283.30
Testing materials						284.51	284.51
Engineering, office expenses, and clerical work					2,907.79	22.85	2,930.64
Inspecting work					324.00		324.00
Cleaning up					53.62		53.62
Excavating					3,267.00		3,267.00
Total	18,124.17	648,145.43	17,066.14	16,602.01	26,786.70	2,887.00	729,611.45

Total expended during year ending June 30, 1903, for labor and material	$29,673.70
Outstanding liabilities July 1, 1903	4,851.54
Total expenditures, as per vouchers	729,611.45

AMOUNTS AND DATES OF APPROPRIATIONS FOR THE WORK.

June 6, 1900	$200,000
March 1, 1901	500,000
July 1, 1902	600,000
July 1, 1902 (deficiency)	250
March 3, 1903	600,000
Total	1,900,250

ABSTRACT OF CONTRACTS IN FORCE JUNE 30, 1903.

Name.	Rate.	Date of approval.	Date of expiration.
Virginia Portland Cement Co., for 157,000 barrels "Old Dominion" cement, net, per barrel	$1.63½	April 1, 1903	Dec. 1, 1904.
Brennan Construction Co.:			
Steel-pipe system, lump sum	72,800.00	April 15, 1903	Do.
Cast-iron pipe, lump sum	75,000.00		
Sand-washer system, lump sum	24,000.00		
Pressure-pipe system, lump sum	1,200.00		
Exterior drainage system and manholes, lump sum	25,000.00		
Central underdrains in filters, per linear foot	1.65		
Interior drainage system, per filter	500.00		
L. E. Smoot:			
Filter gravel, per cubic yard	2.75	April 20, 1903	Do.
Filter sand, per cubic yard	2.65		
Cowardin, Bradley, Clay & Co.:			
Excavation, embankment, and filling, per cubic yard	.30	April 24, 1903	Do.
Puddle, per cubic yard	1.00		
Seeding, per acre	75.00		
Sodding, per square yard	.25		
Concrete in floors, per cubic yard	4.50		
Concrete in walls, per cubic yard	5.10		
Concrete in piers, per cubic yard	6.00		
Concrete in vaulting, per cubic yard	6.50		
Granolithic pavement, per square yard	.90		
Placing materials in masonry, per filter	200.00		
Drainage of roofs, per filter	266.00		

APPENDIX A.

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., February 26, 1903.

GENERAL: In compliance with indorsement dated Office Chief of Engineers, United States Army, January 12, 1903, referring to this office for report an amendment intended to be proposed by Mr. Dillingham to the bill making appropriations to provide for the expenses of the government of the District of Columbia for the fiscal year ending June 30, 1904, and for other purposes, I have the honor to report as follows:

REPORT.

The amendment proposed by Senator Dillingham is as follows:

Toward establishing a slow sand filtration plant, and for each and every purpose connected therewith, including improvements to the distributing reservoir, and for works for the preliminary treatment of water above the same, for the preparation of plans and the purchase of such scientific books and periodicals as may be approved by the Secretary of War, thousand dollars, to be available immediately and until expended.

The above amendment consists essentially of the insertion of a clause providing for the preliminary treatment of the Potomac water before filtration by the slow sand process.

The indorsement from the office of the Chief of Engineers, United States Army, is as follows:

OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
January 12, 1903.

1. Respectfully referred to Lieut. Col. A. M. Miller, Corps of Engineers, for consideration and report.

2. Colonel Miller is requested to thoroughly discuss this question with the consulting engineer, considering any reliable system or systems of preliminary treatment, and to return this paper with report as to the necessity of such preliminary treatment, estimates of the cost of installing and operating the various systems considered, the relative efficiency of these systems, and a definite recommendation as to the system, if any, which should be adopted.

By command of Brigadier-General Gillespie:

JAS. L. LUSK,
Major, Corps of Engineers.

1. *Necessity of preliminary treatment.*—A "report of an investigation of the feasibility and propriety of filtering the water supply of Washington, D. C., with detailed estimate of the cost of the work required," was made by this office under date of March 28, 1900.

In this report the results of experiments on the filtration of the Potomac water, carried on for a continuous period of nine months, were discussed. Two methods of filtration were investigated—the slow sand or English method, and the rapid sand, aided by coagulation, or American method. As a conclusion, from the results of these experiments, it was recommended that the rapid method of filtration, with the use of a coagulant—sulphate of alumina—be adopted for the Washington filtration plant. This conclusion was arrived at from the fact that the experiments clearly demonstrated that during the periods in which the Potomac River water was at its greatest turbidity the English or slow sand method would not afford an effluent acceptable as to turbidity. Further experiments, conducted after the date of the above report, confirmed this conclusion. In my opinion, it is clearly demonstrated that if an effluent satisfactory as to turbidity is required,

it can not be obtained at all times by the slow sand process from the Potomac water at times of high turbidity.

From the above it is evident that if a perfectly satisfactory result of filtration is to be obtained some method of preliminary treatment or preparation of the raw Potomac water is absolutely necessary with a system of slow sand filtration.

There are two methods of preliminary treatment of water to be filtered by the slow sand method:

First. Preliminary treatment by coagulation.

Second. Preliminary treatment by a rapid filtration through coarse material, without coagulation.

Neither of these two methods has yet been applied to filtration plants of large capacity in practice, but the results of experimentation with both are available.

Preliminary treatment by coagulation.—This process consists of applying, in proper proportion and with the necessary care and mechanical appliances, a coagulant to the influent at a time and place sufficiently remote from the filter influent to allow a thorough coagulation and sedimentation.

It is essential in this method that after the coagulant be applied the treated influent be allowed by sedimentation to drop the coagulant and coagulated sediment. For this purpose it is necessary that settling basins be provided.

Mr. Allen Hazen, the consulting engineer for the Washington filtration plant, recommends this method and has submitted a report and estimate therefor, which, with the necessary drawings, are forwarded herewith, marked "A."[a]

Mr. Hazen's estimate of the cost of installing this plant is $85,400. The operating expenses he estimates at $14,750.

In my opinion, this estimate is too low, for the following reasons: Mr. Hazen's estimate for the cost of coagulant is based on the supposition that the use of coagulant will only be necessary for thirty-six days in the year. Coagulant will probably be necessary for a much longer period, in my estimation.

The table below gives the results of experiments on the filtration of the Potomac water for nine months, from June, 1899, to April, 1900.

Record of filter A (English).

[Summary of leading results for each run.]

Number of run.	Date of run.	Duration of run, in days.	Rate of filtration, per acre daily, in million gallons.	Turbidity of effluent.	
				Number of days when less than 0.020.	Number of days when greater than 0.020.
1	June 10, 1899, to July 19, 1899	39	2.5	32	7
2	July 20, 1899, to Sept. 27, 1899	69	3.0	47	6
3	Sept. 28, 1899, to Nov. 3, 1899	36	4.0	36	0
4	Nov. 5, 1899, to Dec. 27, 1899	52	3.5	50	2
5	Jan. 5, 1900, to Mar. 3, 1900	56	3.0	12	44
6	Mar. 3, 1900, to April 9, 1900	37	3.0	5	32

During the remainder of the twelve months the condition of the water was such that a satisfactory effluent water could be obtained without the use of a coagulant.

[a] Not printed.

A turbidity recorded as 0.02 by the platinum wire on Mr. Hazen's scale is considered as acceptable.

The above table is the result of ten months' continuous experiment with the English or slow sand method of filtration, and it may be assumed that for the remaining two months of the year, April and May, the filtered water would have been acceptable.

It will be seen that there were ninety-one days when the effluent was not up to the standard as to turbidity. If it is assumed that for nineteen of these days, which is a fair estimate, the turbidity was so near the standard that it might be unobjectionable to the consumer, there would still remain seventy-two days on which an unsatisfactory effluent was obtained.

The observed turbidity of the Potomac water for the last twenty-four years is given by the table below, and from this it will be seen that the year of observation was not above the average.

Condition of water at Great Falls.

Year.	Very turbid.	Turbid.	Slightly turbid.	Clear.	Number of days observed.
	Days.	*Days.*	*Days.*	*Days.*	
1879	120	71	67	107	365
1880	94	40	44	188	366
1881	123	32	21	189	365
1882	129	29	21	186	365
1883	136	38	30	161	365
1884	173	29	30	134	366
1885	126	52	14	173	365
1886	151	51	36	127	365
1887	121	51	28	164	365
1888	131	26	15	194	366
1889	135	50	33	147	365
1890	122	57	27	159	365
1891	130	61	30	144	365
1892	139	46	41	140	366
1893	114	51	14	186	365
1894	109	59	32	165	365
1895	82	52	26	205	365
1896	118	28	26	194	366
1897	120	35	23	187	365
1898	137	44	16	168	365
1899	151	46	17	151	365
1900	108	50	20	187	365
1901	117	24	11	213	365
1902	146	50	23	146	365
Total	3,032	1,072	646	4,015	8,765
Average	[a] 126	45	27	167	365
Per cent	34	12	8	46	100
1900	[b] 108	50	20	187	365
Per cent	30	14	5	51	100

[a] 84 per cent of 126 = 106.

[b] 84 per cent of 108 = 91.

According to the scale for recording the condition of the water as regards clearness, the numbers 0 to 7, inclusive, correspond to very turbid; 8 to 14, inclusive, correspond to turbid; 15 to 21, inclusive, correspond to slightly turbid; 22 to 36, inclusive, correspond to clear, on the Washington Aqueduct turbimeter scale.

Mr. Hazen in his estimate assumes that coagulation would be necessary for thirty-six days, whereas from the above it would appear that it would be required for seventy-two days or double the time estimated for. This would double the amount of coagulant required. It would also double the amount of storage room and thus add to the cost of

installation of the coagulating plant, or increase the estimate as follows:

Installation of plant, Mr. Hazen's estimate	$85,400
Add for extra storage of coagulant	3,000
Total cost of installation	88,400
For operating expenses, Mr. Hazen's estimate	14,750
Add 100 per cent	14,750
Total	29,500

This would add $1 per million gallons to the cost of operating the filtration plant at a rate of 75,000,000 gallons per diem.

The preliminary method of treatment by coagulation is open to the same objection that is involved in any treatment of potable water by means of chemical substances.

At the hearings before the committees of both the Senate and House of Representatives on the subject of adoption of a plan for the filtration of the Washington water supply, a strong and very decided objection was raised by those representing the citizens of the District of Columbia against the use of a coagulant, especially the sulphate of alumina, in the treatment of the water intended for domestic purposes, and in consequence of this objection the law making appropriation for the construction of a filtration plant was drawn with the intention of designating a slow sand filtration plant in contradistinction to any method employing a coagulant. This objection on the part of the citizens appears as strong as ever.

It would therefore appear that a proper interpretation of the law and a regard for the wishes of those most interested in the subject would exclude the method of preliminary treatment by means of coagulation with sulphate of alumina.

Preliminary treatment by a rapid filtration through coarse material without coagulation.—A preliminary process following the above method has been experimented with at Philadelphia and has been adopted there for the preliminary treatment of the raw water when it is so turbid as to prevent slow sand filtration from producing a satisfactorily clear effluent. The process there experimented with consists in the upward filtration through 38 inches of slag varying in size from 3 inches to one-half inch particles, and finally at the last through 12 inches of sponge. The filtrate thus obtained is then passed to the regular slow sand filter.

The rate of filtration in this preliminary treatment is 60,000,000 gallons per acre per diem, or about twenty times the rate adopted for final or slow sand filtration.

This system is known as the Maignen system and is sometimes called a "scrubber."

Investigations were made of this system by Messrs. Rudolph Hering and George W. Fuller in 1901–2. These gentlemen are sanitary engineers and experts, Mr. Fuller especially having had large experience in the investigation of the subject of the filtration of municipal water supplies.

A copy of the report referred to above was forwarded to the Office of the Chief of Engineers by indorsement of January 5, 1903.

The conclusion of these gentlemen was that the treatment of the

Philadelphia raw water by this system resulted in the removal of 65 per cent of turbidity and 80 per cent of bacteria. It may be concluded from this result that very obstinate raw water could be rendered fit for slow sand filtration by this process.

Mr. Maignen, the inventor of this process, has submitted a description with estimate of cost of his system as adapted to the Washington filtration plant.

Mr. Maignen's estimate for the installation of his system of preliminary treatment is	$375,000
Estimated cost of operation annually	7,280
Add extra cost pumping	5,000
Making cost of operation	12,280

Mr. Maignen's estimate with descriptions and drawings are forwarded herewith, marked B.[a]

Either of the two methods of preliminary treatment—first, treatment with a coagulant, and, second, treatment by preliminary rapid filtration—would, in my opinion, render the raw water capable of being so filtered by the slow sand filtration plant that an acceptably clear effluent could be obtained. I would definitely recommend that at present no system of preliminary treatment be adopted, but that the matter be postponed until a year after the completion of the filtration plant. By that time more definite information as to the success of the practical working of the Philadelphia plant will be available, and after the Washington filtration plant shall have been in operation for a period of one year it can then be definitely ascertained when, how long, and by what method preliminary treatment should be applied.

Very respectfully, your obedient servant,

A. M. Miller,
Lieut. Col., Corps of Engineers.

[a] Omitted.

APPENDIX E E E.

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS IN THE DISTRICT OF COLUMBIA—WASHINGTON MONUMENT.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1903. OFFICERS IN CHARGE, COL. THEO. A. BINGHAM, UNITED STATES ARMY, TO APRIL 30, 1903, AND COL. T. W. SYMONS, UNITED STATES ARMY, SINCE THAT DATE.

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UNITED STATES PUBLIC BUILDINGS AND GROUNDS. SIX OF THE NEW VARIETIES OF CODIÆUMS OF THE PROPAGATING GARDENS.

OFFICE OF PUBLIC BUILDINGS AND GROUNDS,
Washington, D. C., July 20, 1903.

GENERAL: I have the honor to submit the following report of operations upon public buildings and grounds in the District of Columbia under the Chief of Engineers during the fiscal year ending June 30, 1903:

Col. Theo. A. Bingham, major, Corps of Engineers, was the officer in charge from the beginning of the fiscal year until April 30, 1903, on which latter date he was relieved by Col. T. W. Symons, major, Corps of Engineers, by virtue of Special Order No. 37, paragraph 27, A. G. O., February 13, 1903.

Besides the care of public buildings and grounds, this office has also been charged with additional duties, as follows:

1. The preservation, care, and safety of buildings occupied by the War Department in the District of Columbia, except the State, War and Navy Departments building.
2. The care and repair of the Government telegraph line connecting the Capitol with the various Departments and with the Government Printing Office.
3. The immediate charge of the banks of the Potomac River from the north line of the Arsenal (or Washington Barracks) grounds to the southern curb line of N street S.
4. Care of the building on Tenth street NW. where Abraham Lincoln died.
5. Such matters connected with the erection of the statue of General Sherman as may properly devolve upon the War Department.
6. The monument at Wakefield, Va., the birthplace of Washington, and the iron pile dock at the mouth of Bridge Creek, Virginia.
7. The erection, in the national military park at Gettysburg, Pa., of a memorial tablet to Abraham Lincoln.
8. Since March 6, 1901, executive and disbursing officer of the Grant Statue or Memorial Commission.
9. Since May 4, 1901, the same for McClellan Statue Commission.
10. Since August 11, 1901, in charge of that portion of Potomac Park between the tidal reservoir and the Washington Monument Grounds, and between Seventeenth street and Virginia avenue NW. and Maryland avenue and Fourteenth street SW., called hereafter "Monument Park Annex."
11. From April 3 to October 31, 1902, charged with the erection of a pedestal and statue of Rochambeau in Lafayette Park.
12. Since July 26, 1902, in charge of the erection of a monument at Fredericksburg, Va., to the memory of Gen. Hugh Mercer.

PUBLIC BUILDINGS.

REMODELING THE EXECUTIVE MANSION.

During the spring of 1902 it seemed very desirable that the decoration of some of the rooms should be done over.

The President, being desirous that the work should be of as high quality as any in America, called in consultation the firm of McKim, Mead & White, architects, of New York. More than was first con-

templated seemed desirable, and extensive plans were developed. The necessary funds, which were very large in amount, were promptly appropriated by Congress in sundry civil act approved June 28, 1902, as follows:

1. For extraordinary repairs and refurnishing of the Executive Mansion and for each and every purpose connected therewith, including all necessary alterations and additions, cabinetwork, decoration of rooms, covered ways, and approaches, grading, paving, porte-cochère, gates, and electric wiring and light fixtures for house and grounds, all to be done according to plans the details of which shall be approved by the President, and completed in every detail within the sum hereby appropriated, four hundred and seventy-five thousand four hundred and forty-five dollars, to be immediately available and to be expended by contract or otherwise in the discretion of, under the direction of, the President.

2. For a building to accommodate the offices of the President, to be located in the grounds of the Executive Mansion, and for each and every purpose connected therewith, including heating apparatus and light fixtures, furniture, and removal of greenhouses, all to be done according to plans the details of which shall be approved by the President, and completed in every respect within the sum hereby appropriated, sixty-five thousand one hundred and ninety-six dollars, to be expended by contract or otherwise in the discretion of and under the direction of the President, and to be immediately available; and said building shall be constructed with sufficient foundation and walls suitable for a durable, permanent building and of sufficient strength for an additional story when needed.

3. For rent of temporary offices for the President, to be immediately available, two thousand dollars.

In a general way the plans were—

1. To obtain the much-needed additional room for the family of the President on the second story by moving elsewhere the President's offices, clerks, records, telegraph, etc. These offices were not only overcrowded themselves, but deprived the President and his family of much-needed living space.

2. To remodel the old Mansion and redecorate and refurnish it throughout.

3. Until a more elaborate building for the purpose should be constructed, to erect for strictly office use of the President a building in the grounds west of the House and opposite the Navy Department.

The President was desirous that as free a hand as possible should be given the architects consistent with proper disbursement and general supervision and inspection by this office.

A satisfactory contract was finally made with the architects July 16, 1902, and another with Norcross Brothers Company, of Worcester, Mass., contractors under them.

Meanwhile such preliminary work was done as is reported in Annual Report of this office for June 30, 1902.

Owing to the extensive changes to be made, it was necessary for the President and his family to move into temporary quarters elsewhere, and the house No. 22 Jackson place, on the west side of Lafayette square, was secured for this purpose.

The President moved into this house June 23, 1902, and moved back into the remodeled White House November 12, 1902.

It was also necessary for the White House to be stripped bare of all furnishings, fixtures, etc. This was done. As much as possible was stored in the storehouse at the propagating gardens pertaining to this office—the remainder in hired storage rooms. The historic portraits of the Presidents were placed in fireproof storage buildings, and the silver and similar valuables placed in fireproof safe deposit.

Work on the new plans was pushed vigorously all summer.

The following are the main items of the work:

1. Some of the greenhouses west of the House were torn down to make room for the new office building, a one-story structure of brick, painted white, 100 by 50 feet.

2. The remaining greenhouses and the conservatory were torn down and four small greenhouses and one large one erected at the propagating gardens out of this material for White House use.

3. The foundations of the former conservatory were kept and remodeled into laundry and other service rooms, a connection way being built through this part between the White House and the new office for the private use of the President.

4. A similar one-story basement extension was built on the east side toward the Treasury, terminating in a guardroom and porte-cochère for the new driveway and entrance which were cut through the grounds on the east side. This extension is a long cloakroom for the use of the large number of guests received during the winter season.

5. The basement of the House is divided into two unequal parts, separated by partition and doors. The western end, which is about one-third of the whole, contains the kitchens, steward's rooms, ice boxes, etc., much as they were before, but with some changes.

The eastern end has been fitted up with dressing and toilet rooms on the so-called English basement plan.

The original kitchen of the House now contains all the boilers and machinery.

6. The old office stairs and stairs to the basement have been removed and stone stairs from the basement to the first floor substituted. Also stone stairs from first to second floor, beginning opposite the Green Parlor door. A private and service stairs from basement to attic was also built in space taken from the south end of the old anteroom.

7. The so-called Tiffany glass screen in the front vestibule was removed and the whole vestibule and corridor thrown into one. The pillars which formerly divided the vestibule from the corridor, and which dated from the original House, were removed and replaced by others different in style and position.

8. The west end of the first floor corridor was thrown into the old State Dining Room by removing the stairs (which date from General Grant's time), and also removing the brick wall between them for two stories up. This was an original wall of the original House and was of brick and 2 feet thick. In the new room thus formed one of the west windows was closed up to permit the introduction of a large open fireplace.

9. The Red, Blue, and Green parlors remain, except that their decorations were changed and the two mantel pieces from the former State Dining Room, and which belong to the original House, were placed, one in the Green and one in the Red Parlor.

A new door was also cut in the southwest corner of the Green Parlor, connecting it with the Blue Parlor.

10. The form of the East Room was not changed, but the door into the former office lobby was closed up. Four red African marble fireplaces were introduced and the entire decoration of the room changed.

11. The doors at the east and west ends of the first-floor corridor (opening into the East Room and new State Dining Room) were changed from their original arched tops with fan windows to square tops.

12. On the second story, the former office rooms over the East Room were made into bedrooms with bathrooms, and bathrooms were added for each of the other bedrooms.

13. In the attic several servants' rooms were added and made accessible by the service stairs above mentioned.

Furnishings.—The entire first floor was refurnished in rugs, hangings, etc

Most of the former furniture of the first floor was utilized for the dressing rooms in the basement.

On the second floor there was some new furniture and much reupholstering, etc., of the former furniture.

Machinery.—A new heating plant was put in and a new electric elevator, and the house was entirely rewired for lighting and telephonic communication.

Disposal of old furnishings.—The old crystal chandeliers were sent, by direction of the President, and upon request of the Superintendent of the Capitol, to be utilized at the Capitol. Some bookcases were also sent to the same place.

What furniture was not utilized in the new House or by other Departments of the Government was sold at auction by direction of the President.

Photographs.—Seventeen photographs showing the changes made at the White House, both exterior and interior, accompany this report.

MAINTENANCE OF EXECUTIVE MANSION, PRESIDENT'S OFFICE BUILDING, STABLE, AND GREENHOUSES.

Executive Mansion.—Since the date of the reoccupancy of the Mansion by the President on November 12, 1902, the care required for the maintenance of the building and its furniture has been extended. Such of the old furniture as was found suitable for use was put in thorough repair, the stuffed furniture being reupholstered and re-covered. Old carpets were made over into rugs; mattresses, bolsters, and pillows remade; picture and mirrow frames and window cornices regilded; bed draperies made, new window awnings purchased, loose covers of cotton damask made for upholstered furniture, new rubber castors placed on all furniture, and 9 new electric-light fixtures of 4 lights each placed in bedchambers in place of the 1-light fixtures formerly used in those rooms. A 3-inch water pipe was run from the engine room to the attic to convey water for use in case of fire there. During the social season the preparation required for such occasions were made for three State dinners, one day reception, and four evening receptions, and one tea, and six musicales. After those functions were over furniture was replaced in proper position and the House restored to its usual condition. In May and June the House was put into summer dress. The rugs and carpets, amounting to 1,879 yards, were taken up, cleaned, and stored in the Government storehouse at the propagating gardens. All of the draperies—53 window, 5 door, and 23 over draperies—were taken down, cleaned, placed in boxes, and stored in the attic. New wire window screens were made where required and old ones repaired. Electric-light fixtures and appliances and the plumbing and heating apparatus were maintained in good condition and necessary repairs made. Seventy bay trees and 70 boxwood

THE SOUTHERN FAÇADE, WHITE HOUSE, SHOWING COLONNADES, LOOKING NORTH ON THE MERIDIAN.

(Taken at 12 M.)

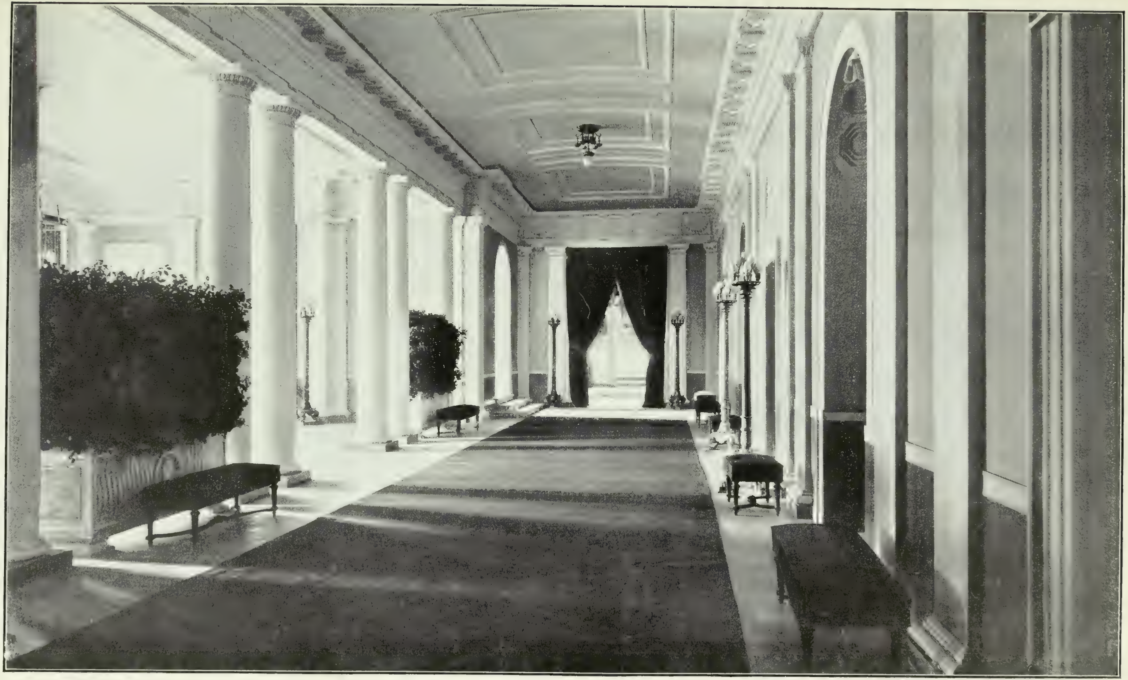
THE EAST TERRACE AND WHITE HOUSE, LOOKING WEST FROM THE PORTE COCHÈRE.

VIEW OF NEW EAST ENTRANCE AND TERRACE, WHITE HOUSE, FROM TREASURY BUILDING, LOOKING WEST.

EAST TERRACE, SHOWING TREES AND FOUNTAINS, WHITE HOUSE, LOOKING WEST.

THE WEST TERRACE AND WHITE HOUSE, LOOKING EAST, FROM ABOUT EXECUTIVE-OFFICE BUILDING.

VIEW OF NEW EXECUTIVE OFFICE, WITH WHITE HOUSE AND WEST TERRACE, TAKEN FROM THE NAVY DEPARTMENT BUILDING.



MAIN CORRIDOR, WHITE HOUSE, AFTER REMODELING, LOOKING TOWARD AND INTO EAST ROOM.

NEW MAIN STAIR CASE, TO SECOND STORY, WHITE HOUSE. TAKEN THROUGH THE GREEN-ROOM DOOR, LOOKING NORTH.

NEW MAIN STAIRWAY, WHITE HOUSE, LOOKING SOUTH FROM LANDING.

REMODELED EAST ROOM, WHITE HOUSE. VIEW LOOKING NORTHEAST.

REMODELED EAST ROOM, WHITE HOUSE. VIEW LOOKING NORTHWEST.

CORNER OF REMODELED EAST ROOM, WHITE HOUSE. VIEW LOOKING NORTHEAST.

NEW STATE DINING ROOM, WHITE HOUSE. VIEW LOOKING NORTHWEST.

REDECORATED RED PARLOR, WHITE HOUSE. VIEW LOOKING SOUTHWEST, STATE DINING ROOM ON THE RIGHT.

REDECORATED BLUE PARLOR, WHITE HOUSE. VIEW LOOKING SOUTHEAST.

REDECORATED GREEN PARLOR, WHITE HOUSE. VIEW LOOKING SOUTHEAST. EAST ROOM ON LEFT OF PHOTOGRAPH.

THE NORTHWEST ENTRANCE, SHOWING NEW DRIVEWAYS TO WHITE HOUSE AND EXECUTIVE OFFICE.

trees were purchased and placed on the east and west terraces, and 12 stone settees were also purchased for those terraces.

Sundry civil act approved April 17, 1900 (p. 12), provides:

> And hereafter, a complete inventory, in proper books, shall be made annually by the steward, under the direction of the officer in charge of public buildings and grounds, of all the public property in and belonging to the Executive Mansion, showing when purchased, use to which applied, cost, condition, and final disposition, to be submitted to Congress with annual report of officer in charge of public buildings and grounds.

Owing to the changes made in the White House and in its furniture and furnishings, it is impossible this year to make the list as complete as could be desired. A list showing the articles purchased during the year, and so far as possible the disposition made of those no longer serviceable is, however, submitted herewith as Appendix A, and this, taken with the lists published in the two preceding annual reports, gives the information required by the law.

President's office building.—Such care as has been necessary has been extended to this building since its occupancy in November, 1902. The walls of the President's office and the Cabinet room were given a coat of shellac. The two lavatories in the toilet room on first floor were moved over to the south side of the room and reset, and two water-closets with marble partitions, and swing doors were set in the places vacated by the lavatories and all necessary pipe connections and repairs to tile floor, plastering, etc., made and the walls and ceiling of the room painted. The stairway leading from the anteroom outside of the Cabinet room to the basement was taken out, the opening floored over and the walls and ceiling in the basement where the stairway was removed replastered. In order to carry off, as far as possible, water which stood under the floor of the basement, a blind drain was put in and lead to a cesspool with a back pressure valve and connected with the main sewer. A large area window was put in the basement wall under the Cabinet room to afford better ventilation for the basement.

The President's stables.—The stables at present used by the President, the Executive Office, and the Office of Public Buildings and Grounds, should be rebuilt for two important reasons:

First.—They are situated in the President's Park, directly south of the State Department, on a plot of ground which will undoubtedly in the near future be selected as the site of a monument to one of the nation's great men. When such a monument is erected, the stables should be removed and the ground occupied by them should be improved and beautified to make a fitting setting for the monument.

Second.—The stables are inadequate and in nowise corresponding to or commensurate with the splendid residence of the President, or his stable needs, or the variety and importance of the business of the Executive Office and the Office of Public Buildings and Grounds, which are all accommodated together. The present stable is a low brick structure, built many years ago, and so near the ground as to be damp and unhealthy for horses. In connection with it is an old wooden stable, which is needed to increase the capacity to the requisite amount. To build a proper and adequate stable on a new site further to the south on Seventeenth street would cost about $60,000. Such a stable would accommodate the animals, carriages, and wagons at present in use, and provide for the reasonable and natural increase which can con-

fidently be expected in the future. It should be built so as to furnish living rooms for the man in charge of the stables and some of his principal assistants, and it should also furnish needed storerooms for such bulky and unsightly things as the band stands, chairs, music racks, etc., used by the Marine Band for their public concerts in the White House grounds, and for boxes, crates, etc. On account of the desirability of the White House being thrown open to the public to the greatest extent possible, there are no storerooms where these large and unsightly things can be properly provided for.

In consideration of the foregoing, it is earnestly recommended that an appropriation be made of $60,000 for building a stable on a location in the President's Park, to be selected by the President, to the south of the present stable, for the use of the President, the Executive Office, and the Office of Public Buildings and Grounds.

The following repairs were made to the old stable building during the year: New floors were laid in the stalls, and the stall rooms and harness rooms painted. The wooden front of the carriage shed was repaired and given two coats of paint, and minor repairs made to doors and windows. A new asphalt drive was constructed from the entrance to the stable yard at Seventeenth street to the carriage houses. The old asphalt surface of the floor under the carriage shed was torn up and all but a space 18 by 18½ feet resurfaced with new asphalt. The space mentioned was relaid with a granolithic pavement for a wash floor. The area paved with asphalt amounted to 339 square yards, and that with granolithic about 37 square yards. Sixty-eight feet of 1¼-inch galvanized-iron water pipe were laid in carriage houses. The unpaved ground at the west front was sodded and a connection made with the water main on Seventeenth street and a 2-inch water pipe laid to the newly sodded ground. Gas pipe was run and a new fixture placed in position to light the carriage house, and 100 feet of new gas pipe was run to improve the lights.

STABLE OF PUBLIC BUILDINGS AND GROUNDS.

This stable is a small wooden structure in rear of the President's stable. During the year a new floor was laid in one of the stalls, the floor behind the stalls was repaired, minor repairs made to doors and windows, and the wash floor in the carriage room given three coats of paint.

GREENHOUSES, EXECUTIVE MANSION.

The old material saved from the demolition of the greenhouses in the White House grounds, which were torn down to make room for the erection of the President's Office building, was utilized so far as practicable in the erection of five of the houses at the propagating gardens, which were completed late in the autumn of 1902. Since their completion the usual care has been extended to maintain them and their heating apparatus in good condition. The ground in front of the houses was improved by grading and sodding. These greenhouses are not of sufficient capacity to do the work required of them, but in their reerection the best was done with the funds available. They should be increased by the erection of at least two additional houses. One of these houses is needed for properly caring for the large and

valuable bay trees and boxwood trees which occupy the east and west terraces of the White House in summer, but which must be housed during the winter months. The second house is much needed to help provide the supply of flowers required for use at the White House at state functions, etc. Suitable houses can be built for about $6,000, and an item for that purpose is included in the estimates and earnestly recommended.

GROUNDS OF EXECUTIVE MANSION.

The following work rendered necessary by the alterations and additions to the Executive Mansion was done during the spring of 1903: The old lodge used by the watchmen, being no longer needed for that purpose, was moved to the southeast part of the grounds near the east gate. The small frame building used as an office by the head gardener was removed from the grounds and hauled to the Smithsonian grounds for use as a lodge house there. The ground at the east side of the house, including the slopes, etc., near the new east terrace, was graded, and 6,360 square yards of sod laid. The ground south of the east terrace was covered with soil and sown with grass seed. The top of the old water cistern at the southeast corner of the Mansion was broken in, and the cistern filled with clay. The area south of the west terrace, formerly occupied by the rose house, was graded and the ground laid out into a large rectangular flower bed with a walk 5 feet wide around it. A new clothes-drying yard was laid out south of the west wing of the west terrace, and inclosed with a lattice fence 8 feet high. The necessary posts with crossbar and wire lines were erected and wooden board walks laid within the inclosure. The ground south of the President's Office building was graded, and portions of it sodded. A new wire-screen fence was built on the west side of this ground. An unused asphalt foot walk in the east side of the north grounds was taken up and the vacant ground left thereby prepared for grass. All of the old drain pipes and water-supply pipes from the old greenhouses were removed and new connections put in for watering the newly sodded area.

The old 50-foot asphalt pavement on the semicircular roadway leading up to the north entrance to the Mansion was torn up, the drive narrowed to a width of 25 feet, and a macadam pavement laid upon it. The strip of 12½ feet on either side was sodded. The 14-foot asphalt drive running east and west from the northeast corner of the Mansion to the north front entrance to the President's Office building was torn up and replaced with a granolithic foot walk 5 feet wide. The ground left bare on either side of this walk was sodded. The old asphalt foot walk leading from the northwest gate to the office building was taken up, and a 20-foot driveway with a macadam pavement constructed in its place. The water pipe in the south part of the grounds was extended by laying 284 feet of 2-inch pipe and 28 feet of 1¼-inch pipe. The water pipe south of the new east terrace was extended by laying 9 feet of 1¼-inch pipe. Water was introduced into the grounds east of the east terrace from the 4-inch water main in East Executive avenue, and 60 feet of 1-inch lead pipe and 72 feet of 1¼-inch iron pipe laid and a hose valve placed on each side of the lawn.

In addition to the foregoing, the work required to maintain the grounds in good condition was performed. This work consisted of

mowing lawns, edging their margins, and sodding or seeding bare places on them, cleaning gutters and drain traps, dressing gravel walks, sweeping paved roads and walks, trimming trees and shrubs and caring for flower beds. Twelve flower beds in the north and south grounds were graded to the level of the surrounding lawn surface and sodded over, and four large new flower beds were laid out in the north grounds. Work was commenced on June 1 scraping, cleaning, and painting the iron fence inclosing the grounds, and by June 30 the following length of fence on the north and east sides of the grounds had been painted: Five hundred and sixty-nine feet of fence with one coat of paint, 966 with two coats, and 250 feet with three coats.

In accordance with the usual custom the grounds were thrown open to the children on Easter Monday, April 13. Temporary wire fencing was put up around trees and shrubs and along the tops of the grassed terraces to prevent injury by the crowds. The band stand was erected, but owing to unfavorable weather the band did not play in the afternoon as was intended. Owing also to the bad weather there was a very small crowd in the grounds, and consequently the usual amount of cleaning the day after was not necessary and what was required was done by the regular force employed to care for the grounds, the cost of the work amounting to about $24.

The following work was done for draining the roadways in the south grounds under a special appropriation provided for the purpose in sundry civil act approved June 28, 1902: Eight hundred feet of 6-inch terra cotta drain pipe, 700 feet of 8-inch, and 500 feet of 12-inch were laid, and 30 brick catch basins constructed at turns in the roads and connected with the pipes.

A general plan of these grounds, showing the exterior changes made during the fiscal year 1903, accompanies this report.

There are certain improvements which should be made in the White House grounds to make them conform to the new conditions. The new public entrance at the east and the office entrance at the west, combined with the retained north entrance, render unnecessary the double roadways which reach the Mansion from the south. This duplicate system of roadways is an inheritance from old conditions, which no longer exist. Good taste and judgment require that the unnecessary roadways should be done away with, as they are not beautiful and are expensive to maintain, and grass, trees, shrubs, and gardens substituted for them. In many other ways these private grounds pertaining to the White House should be improved and beautified to make them conform to this splendid residence and to the development of private grounds and gardens throughout the country. The house of the President should have a proper and fitting setting amidst grounds and gardens of unexceptionable beauty. The amount appropriated for the grounds inside the iron fence—$4,000—is not enough to enable all the improvements desired to be made, and it is respectfully urged that in the next bill it may be increased to $7,500.

PORTRAIT OF WILLIAM McKINLEY.

Sundry civil act for the fiscal year ending June 30, 1903, approved June 28, 1902, contained a provision "For purchase for the Executive Mansion of an oil portrait of the late President McKinley, a sum not to exceed (including frame) two thousand five hundred dollars."

After careful consideration the portrait (with frame) of William McKinley, by W. D. Murphy, of New York, was purchased by this Office in March, 1903, for the sum of $2,500, and hung in the entrance vestibule of the Executive Mansion.

HOUSE NO. 516 TENTH STREET NW., WHERE ABRAHAM LINCOLN DIED.

This property was purchased by the United States in November, 1896, since which date it has been under the supervision of this Office.

By authority of the Secretary of War dated October 9, 1899, Mr. O. H. Oldroyd is allowed to occupy this building, with his family, as custodian without pay, and to exhibit his Lincoln Museum and to charge a small entrance fee therefor.

During the year repairs were made to the front door, the door was varnished, and the door frame painted. Minor repairs were made to the plumbing.

BUILDINGS OCCUPIED AS OFFICES BY THE WAR DEPARTMENT, EXCEPT STATE, WAR, AND NAVY DEPARTMENTS BUILDING.

By order of the War Department dated June 30, 1893, all buildings occupied as offices by the War Department, except the State, War, and Navy Departments building, were placed under the charge of this Office, so far as their preservation, care, and safety are concerned. Between July 1 and September 8, 1902, the buildings thus occupied were 12 in number, as follows:

Army Medical Museum and Library, Seventh and B streets SW.
Ford's Theater building, 511 Tenth street, NW.
Annex to Ford's Theatre building, 509 Tenth street NW.
No. 610 Seventeenth street NW., Record and Pension Office, War Department.
Southwest corner of Seventeenth and F streets NW., Office of Depot Quartermaster, United States Army, and photograph gallery, Adjutant-General's Office.
No. 1725 F street NW., branch printing office, War Department.
No. 1712 G street NW., publication branch, Record and Pension Office, War Department.
No. 1744 G street NW., Ordnance Department and Signal Office, United States Army,
No. 1814 G street NW., Medical Dispensary, United States Army.
Annex to Winder Building, Ordnance Department, United States Army.
War Department stables, G street, between Seventeenth and Eighteenth streets NW.
Lemon Building, No. 1729 New York avenue NW., occupied by supply division, War Department, etc.

On September 8, 1902, the chief of the supply division of the War Department notified this Office that the Department had rented an additional building, No. 601 Eighteenth street NW., for use as an annex to the Insular Bureau, making thirteen buildings in all.

Monthly inspections have been made of these buildings during the year, and they are believed to be in good and safe condition for the purposes for which they are being used.

THE WASHINGTON NATIONAL MONUMENT..

The usual care was extended to maintain the Monument and its machinery in good condition and to keep the interior of the shaft clean.

The walls, stairs, and landings were swept whenever necessary, the memorial stones cleaned, and the floor plates of the stair landings frequently oiled to prevent rusting. All of the iron work from the floor

up for a distance of 10 feet, consisting of columns, tie rods, angle irons and hand rails, the elevator cage, partition of storeroom and the front door and frame were painted, also the counter weights of elevator and 200 feet of chain. Two electric fans were placed in the elevator car for ventilation. The electric elevator and machinery were kept in a cleanly condition. All bolts and nuts were set up tight, the large gear on cable drum adjusted, the sheave wheels for cable on 500-foot landing taken down, faced and replaced, and the east cable in counterweight and west cable on elevator tightened. The eight windows and the wire work around the elevator framework at the top were painted. The old wooden door at the entrance was torn out and replaced by a better door with necessary trimmings. Storm doors were also placed at the entrance and all woodwork there was painted. Three electric lights were placed in position on the first floor.

The electric elevator was run and the electric lights were in operation daily, except on Sundays and holidays, when the Monument was closed, and on the following dates, when, owing to the coal strike, it was impossible to get sufficient coal to run the plant: In October, 1902, the plant was in operation only from the 6th to the 13th of the month during the Encampment of the Grand Army of the Republic. In November and December, 1902, the plant was in operation only two days each week, viz, on Friday and Saturday, and from January 1 to 14, 1903, only three days each week, viz, on Thursday, Friday, and Saturday. An adequate supply of coal having been obtained, the plant was in operation daily except Sundays and holidays from January 15, 1903. During the periods that the machinery was shut down from lack of coal, visitors made the ascent by the stairs, and the interior of the shaft was lighted by kerosene oil lanterns placed on the landings.

The electric elevator and its machinery were inspected each month by a casualty company of New York, who furnished monthly certificates of their good condition. In its report dated September 4, 1902, of the inspection made August 30, the company says: "When it is considered that portions of this mechanism have been in operation since the construction of the Monument the general condition, care, and management can not be too highly commended." In addition to the monthly inspection mentioned a daily inspection was made of the safety appliances on the elevator by the employees of the Monument before starting to carry passengers, and a test of those appliances was made twice each week, also by the employees.

In the motor room all of the woodwork inside and outside, the roof, and iron railing, and the brickwork in the area were painted, the floor given two coats of floor stain and varnished, and the paint work on engine and motor painted and varnished. All the electrical connections with the motor were cleaned and adjusted.

At the power house leaking places in the roof were repaired and the roof, tin work, and gutters painted. The walls of the boiler room were whitewashed and the brickwork around the boilers repaired, pointed up, and whitewashed. A new furnace front was put to boiler No. 2 and the furnace fronts scaled, cleaned, and painted. The steam pipes and water pipes, the condenser, air pump, and all pipes connected therewith were painted. Both boilers were washed out, their tubes scaled, and the boilers tested. A tank for hot-water feed was set in place in floor of boiler room and connected with the small feed pump. The window frames, sashes, and doors, water spout, and cupola of the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N.

GENERAL PLAN OF

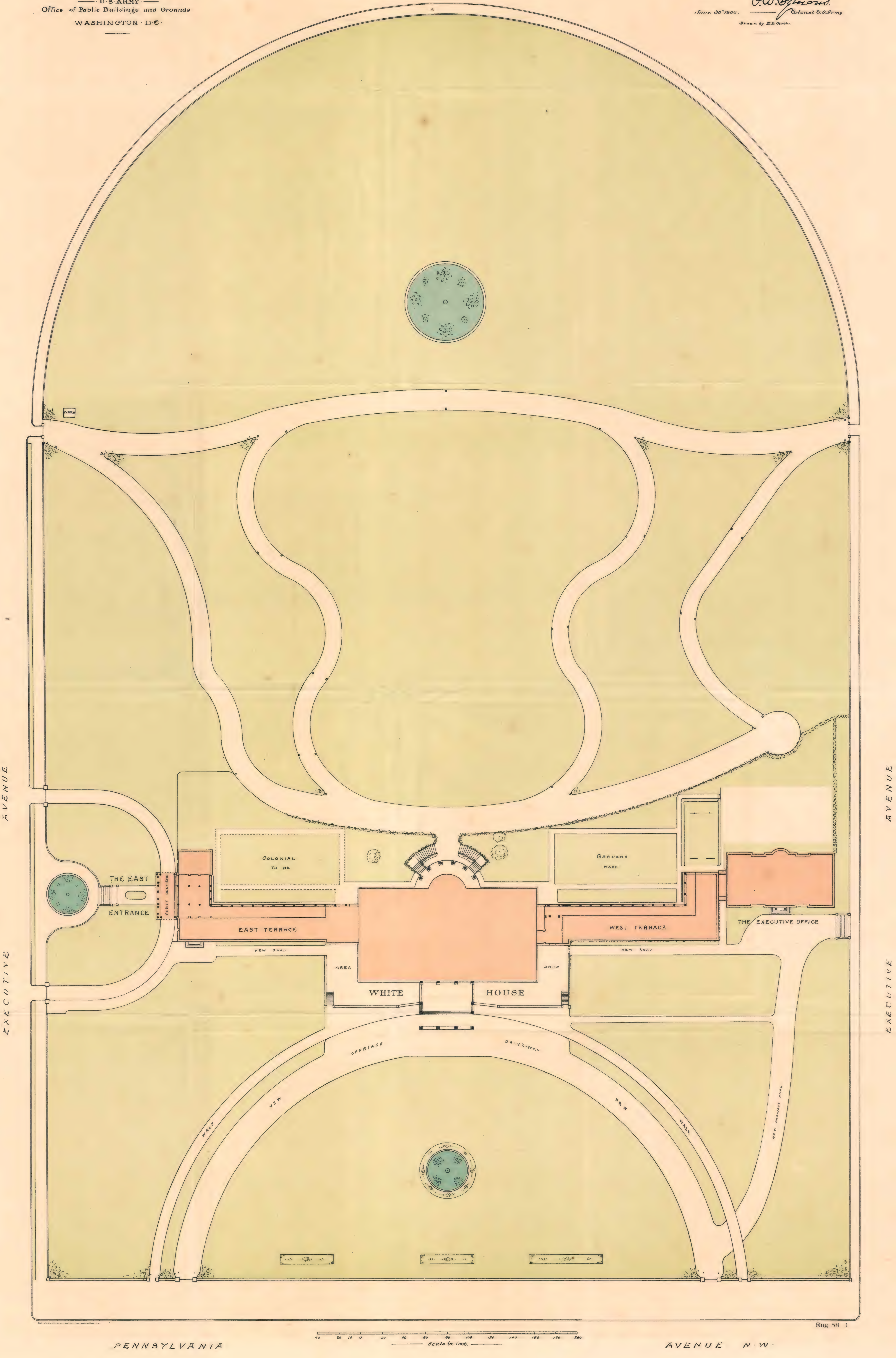
WHITE HOUSE, EXECUTIVE OFFICE AND GROUNDS

SHOWING THE EXTERIOR CHANGES MADE DURING

THE FISCAL YEAR ENDING JUNE 30th 1903.

CORPS OF ENGINEERS
U·S·ARMY
Office of Public Buildings and Grounds
WASHINGTON·D·C·

To accompany the annual report of
F. W. Symons.
June 30th 1903. Colonel U.S. Army
Drawn by F. D. Owen.



Eng 58 1

EXTRACT COPY

MAP

Showing structures in Water Street and along Potomac River water front of
WASHINGTON, D.C.
from the Arsenal Grounds to 15th street West. In three Sections.
Prepared for use in case of
UNITED STATES vs. MARTIN F. MORRIS.
from Survey and Map by L. R. Grabill, U. S. Asst. Engr. June & July 1895.
and from Survey of Howell & Taylor, July 1901 under the supervision of
Henry B. Looker
Surveyor of the District of Columbia

I certify to the correctness of the above description
of this map

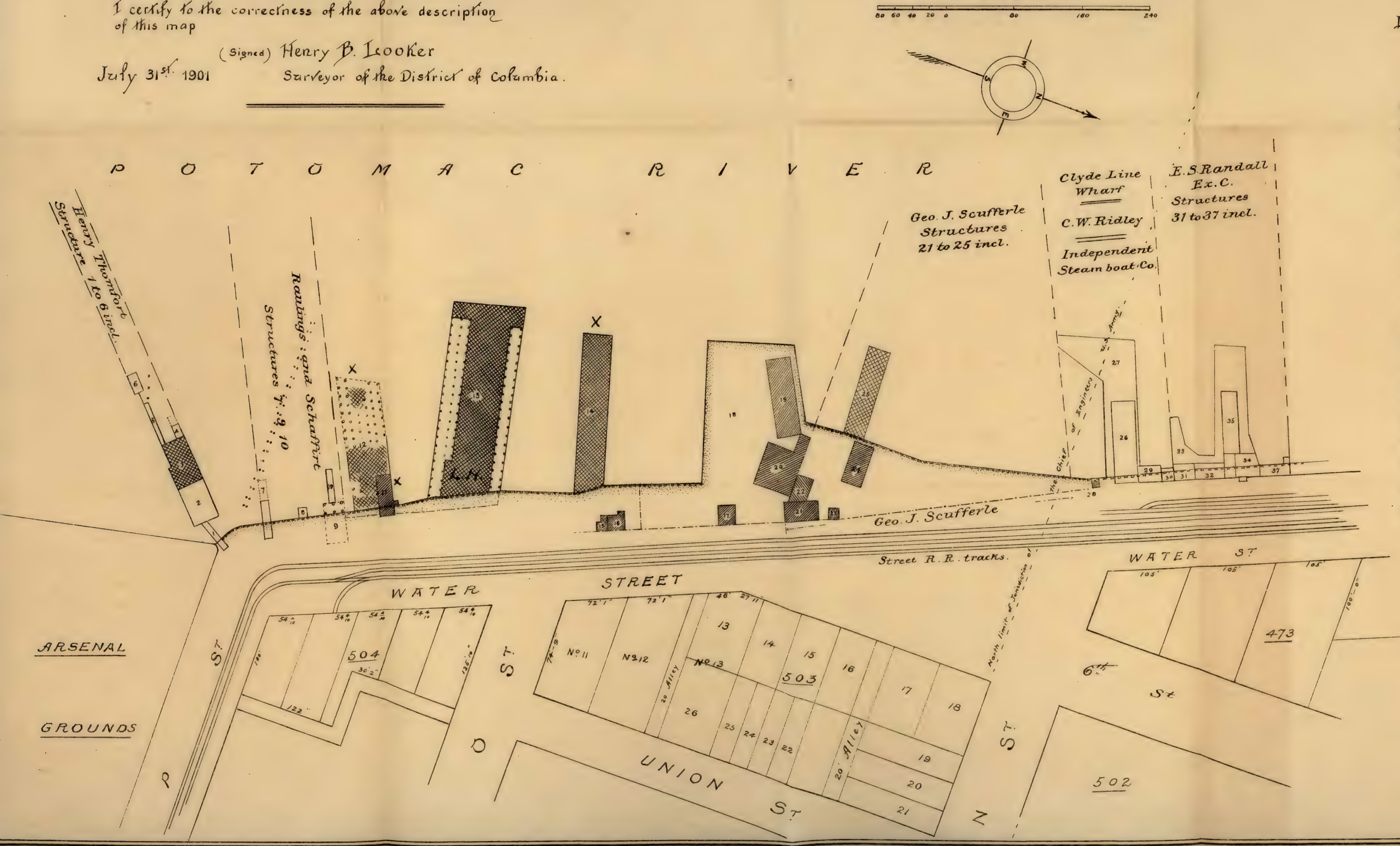
(Signed) Henry B. Looker

July 31st. 1901 Surveyor of the District of Columbia.

SECTION 1

ARSENAL GROUNDS TO N STREET

WASHINGTON · D · C ·



Legend.

Frame Building or covered shed ---------

Pile wharf ---------

Piles driven without flooring ---------

Stone wall along water edge ---------

Limits of filled wharf ---------

Notes.

By the Decree of the Supreme Court of the District of Columbia entered in the case of United States vs. Morris, et al, February 14th 1903. the following awards were made as the valuation of the various structures erected on the wharf property under charge of the Chief of Engineers, U.S.A. and for which an appropriation was made by Congrees, Act approved March 3rd 1903.

To Henry Thomfort for structures 1–6. inclusive	$550.00
" Frank T. Rawlings and William G. Shaffirt for structures 7. 9 and 10	42.00
" Averilla Lambert and Martina Carr for structure 18	5.453.00
" " " " " " and Thomas R. Riley. jointly. 17.19.20	1.800.00
" George J. Schufferle for structures 21 to 25 inclusive	1.5000.00
Total	$9.345.00

There were no claimants for structures 8 and 11 to 16 inclusive.
Application has been made by Edward Whyte for lease to him of Structure No. 12.
Structure No. 13 is occupied by the U.S. Light House Board.
Structure No. 14 is used by the Naval Reserve of the D. C. Militia under revocable license granted by the Chief of Engineers of the Army, February 26th 1903.
Structure No. 18, with the buildings thereon, is occupied by Thomas R. Riley under a month to month lease, made June 16th 1903, between the Chief of Engineers U.S. Army, and Mr Riley.

To accompany the annual report of
[signature]
June 30th 1903. Colonel U.S. Army.

engine room were painted, and the floor in the room and the steps to boiler room given two coats of floor stain. Necessary attention was paid to the dynamo engine; its rods and valves were repacked, the steam chest and cylinder jackets repainted, and the walls of cylinder oiled. A lubricator with double sight feeds was purchased and placed on the engine for the purpose of better lubricating the valve and both cylinders.

The walls and ceiling in the waiting room were patched and painted and all woodwork given a coat of hard oil.

At the lodge house the office of the custodian of the Monument was moved from the small room to the large room and the former fitted for a storeroom. The walls and ceilings in office and storeroom were painted and the floors in those rooms and in the waiting room given a coat of floor stain. Portions of the wainscoting and flooring in the latter room, which had rotted out, were repaired and painted. Two steam coils were made and connected with the boiler, one for heating the office room and the other for heating the waiting room, the coils bronzed, and drip pans made for the valves.

In the men's toilet a hole was cut in the wall to connect with the air flue for ventilation, a two-stall urinal was placed in the room, a new oak seat placed on closet, and all woodwork painted. Door plates and new check and spring were placed on the main door. A new drinking fountain was purchased and placed in position on the north side of the lodge near the board walk for the accommodation of visitors.

The following table shows the number of visitors to the top of the Monument each month, both by the electric elevator and by the stairway, the total number during the year, and the aggregate number since the shaft was opened to the public, October 9, 1888:

Month.	Number by the electric elevator.	Number by the stairway.	Total.	Aggregate since October 9, 1888.
1902.				
July	10,172	3,545	13,717	2,120,139
August	12,901	5,631	16,532	2,138,671
September	8,411	8,407	16,818	2,155,489
October	5,280	30,434	[a] 35,714	2,191,203
November	3,651	3,569	7,220	2,198,423
December	2,648	5,040	7,688	2,206,111
1903.				
January	6,556	2,618	9,174	2,215,285
February	8,050	1,980	10,030	2,225,315
March	9,472	1,829	11,301	2,236,616
April	13,612	2,810	16,422	2,253,038
May	10,089	1,544	11,633	2,264,671
June	11,912	2,389	14,301	2,278,972
Total	102,754	69,796	172,550	....

[a] The large increase in the number of visitors during the month of October, 1902, is accounted for by the fact that the Grand Army of the Republic held its thirty-sixth national encampment in this city from the 6th to the 13th of that month.

Data relative to Washington Monument.

Height above mean low water	596 feet 4¾ inches
Height above doorsill	555 feet 5⅛ inches
Side of base—outside	55 feet 1½ inches
Side of base—inside	25 feet
Depth of foundation (sand and clay)	38 feet
Foundation on a side	126 feet 6 inches
Area	16,002.25 square feet

Top, side of Monument	outside	34 feet 6 inches
	inside	31 feet 6 inches
Walls, thickness	base	15 feet ¼ inch
	top	18 inches
Weight of capstone		3,300 pounds
Weight of the whole Monument		81,120 tons
Mean pressure at base		5 tons per square foot
Pressure on foundation nowhere greater per square foot than		9 tons
Near edges, less than		3 tons
(Coast Survey Report, December 1, 1884.)		
Taper of Monument		¼ inch to 1 foot
Memorial stones (beginning at 30 feet, stopping at 280 feet)		179
Steps		898
Landings		50
Windows, at top only		8
Six are 3 feet by 1 foot 4 inches.		
Two are 3 feet by 2 feet.		
Cost		$1,300,000
Corner stone laid July 4, 1848.		
Capstone set December 6, 1884.		
Dedicated February 21, 1885.		
Elevator, electric, time of travel		5 minutes
Elevator load		35 persons
Weight of car empty		5,670 pounds
Weight of car loaded, 35 persons (1 person equals 150 pounds)		10,920 pounds
Weight of counterweight		8,040 pounds
Cables		1½ inches diameter
Dynamo		50 kilowatts, 250 volts
Engine, double worm.		
Speed of elevator, 100 feet per minute.		
Engine governor throws off current at 105 feet per minute.		
Car safety stops car at 150 feet speed per minute.		
Elevator tested at 6 tons.		

There are several improvements at and about the Washington Monument that are needed.

First. The lower portion of the Monument to the south of the elevator shaft should be made into a comfortable reception room by sheathing it and ceiling it in and providing it with suitable heating, lighting, and ventilating appliances. Practically all visitors to Washington go to the Monument, and in inclement weather they have to wait inside the structure until the time comes for them to make the ascent. The place where they must wait is ordinarily very damp, cold, and uncomfortable, the walls being the rough stone as left by the builders, upon which moisture condenses very freely. People sitting and waiting in this place are also exposed to the down draft of the chilled, cave-like air of the interior of the Monument. The conditions are particularly favorable to the contracting of severe colds and pneumonia. As there are some 150,000 to 200,000 people of the country, many of them women and children, who visit the Monument every year, the aggregate damage to health each year may be very great.

For the protection of the thousands of people who come from all over the country to visit this grandest of monuments the reception room recommended should be provided. The necessary expense for this room, all of strictly fireproof construction, with heating, lighting, and ventilating apparatus, is estimated at $2,500.

Second. The road surrounding the Monument is a gravel road; the round-top hill on which the Monument stands is a very windy spot, and the Monument, like the notorious flatiron building in New York City, acts with the winds to produce severe whirlwinds. The conse-

quence is that when the weather is dry and windy the air about the Monument is filled with flying sand and gravel to an almost incredible extent, which is painful and annoying to all who have the fortune to visit it at such times.

It is respectfully recommended that in consequence of this condition of things as enumerated above the roadway surrounding and in the immediate vicinity of the Monument be paved with asphalt. The expense of this work is estimated at $7,500.

IMPROVEMENT OF PUBLIC RESERVATIONS IN THE DISTRICT OF COLUMBIA.

The public parks provided for in the original design of the city of Washington, after about a half century of exploitation in a primitive way, received the first positive impulse on lines of systematic improvement in the Downing plan of the fifties. The demise of that skillful architect and landscape gardener terminated further movements in that direction. Owing to conditions over which there was no control until the seventies, the real beautifying of the city and its parks remained in abeyance. In the early part of the decade mentioned Congress took up the subject in earnest. The Board of Public Works for District purposes and the officer of Engineers in charge of public buildings and grounds representing the General Government, aided by liberal appropriations by Congress, then began the working out of a project based on scientific and artistic principles. During the entire period of upward of a century, the original city commissioners appointed by President Washington, and their successors, now represented by the officer in charge of public buildings and grounds, have had charge of park improvement. To continue the same policy of administration and execution finds its strongest support in the comprehensive system and satisfactory results exemplified in the beautiful Washington of to-day.

This Office has in its files the old records of parks, maps, deeds of transfer, and the original L'Enfant map of Washington, and a well-equipped garden plant, all tending to show that up to the present the development, care, and maintenance of the parks as laid out by L'Enfant and approved by President Washington have been carried out according to the direction and appropriations by Congress; and it is along these historic lines that new endeavor should be encouraged and expansion carried on.

The future development of the park system of the city of Washington has received the attention of this Office for a number of years, and studies of a comprehensive character have been prepared not only for the improvement of the parks within the city limits, but also for connecting them with those in the suburbs.

The improvement of the reclaimed flats (now known as Potomac Park), in connection with the beautification of the Mall, on lines proposed by L'Enfant, and later by this Office, is a subject well worthy the serious attention of Congress.

In consideration of this long-established policy, so far as this Office is concerned, I have the honor to submit the following retrospect of work done during the past year and recommendations for the attainment of the best results along similar lines during the next.

The work of the Office is divided as follows:

1. Clerical department.
2. Horticultural department.
3. Engineering department.
4. Police department.
5. Executive Mansion, greenhouses, and grounds.
6. Washington Monument.
7. Departmental telegraph.

For the purposes of administration all the parks under this Office are divided into three divisions, viz:

East division: All east of North and South Capitol streets.
Northwest division: All west of North Capitol street and north of B street north.
Southwest division: All west of North and South Capitol streets and south of B street north.

The area covered by the park spaces of the District of Columbia under the charge of this Office is 440.234 acres.

There are in all 303 reservations, varying in size from 250 square feet to 82 acres.

Two park spaces were separated from the park system under this Office during the year as follows:

(*a*) Reservation 249, being the triangle at the intersection of Georgia avenue, Fourth and N streets SE., containing 0.0119 acre.

(*b*) Reservation 250, being the triangle at the intersection of Georgia avenue, Fifth and N streets SE., containing 0.0041 acre.

These spaces were transferred to the Navy Department for naval purposes (proposed enlargement of navy-yard) under authority of the act of Congress approved March 3, 1903, volume 32, Statutes, Part I, page 1186.

The 303 reservations are classified as follows:

	Number.	Acres.
Highly improved	107	353.29
Partially improved	97	28.091
Unimproved	99	58.853
Total	303	440.234

Between June 30, 1902, and June 30, 1903, part of the $20,000 appropriated by Congress for "improving various reservations" was devoted to unimproved ground, and the first stages of improvement was accomplished on three reservations, comprising 0.021 acre in various parts of the city, as shown in the table below.

The first stage of improvement consisted of grading, introducing water, covering with soil, sowing with grass seed, and inclosing with low, open iron post-and-chain fences.

Reservations improved during the fiscal years given.

1897–98.				1898–99.				1899–1900.			
Unimproved.		Previously partially improved.		Unimproved.		Previously partially improved.		Unimproved.		Previously partially improved.	
No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.
85	0.173	29	0.329	61	0.050			19	3.020	61	0.050
207	.073	31	.338	140	.160			47	.025	154	.273
211	.105	193	.215					77	.353	163	.176
		194	.131					98	.198		
								99	.112		
								100	.141		
								102	.097		
								122	.365		
								123	.394		
								125	.414		
								126	2.102		
								131	.216		
								163	.176		
								187	.092		
								195	.288		
								206	.111		
								208	.085		
								210	.249		
								211	.105		
								212	.094		
								213	.076		
3	.351	4	1.013	2	.210	......	....	21	8.713	3	.499

1900–1901.				1901–2.				1902–3.	
Unimproved.		Previously partially improved.		Unimproved.		Previously partially improved.		Unimproved.	
No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.
78	0.108	57	0.055	73	0.014	78	0.108	155	0.004
79	.027	62	.220	81	.093			255	.015
124	.224	64	.315	82	.102			275	.002
159	.152	188	.085	112	.199				
160	.058	206	.111	138	.051				
165	.056			143	.022				
166	.072			146	.126				
190	.148			147	.087				
191	.131			148	.094				
192	.196			177	.012				
201	.507			178	.164				
209	.103			182	.108				
230	.375			183	.108				
251	.250			184	.174				
259	.124			196	.118				
260	.088			229	.224				
266	.131			276	.020				
267	.145			277	.017				
271	.015			285	.241				
277	.259								
20	3.169	5	.886	19	1.974	1	.108	.3	.021

In connection with the subject of the United States public reservations in the city of Washington, it is considered proper to invite attention to the desirability of correcting a typographical error which appears in one portion of the act of Congress approved July 1, 1898 (vol. 30, Statutes, p. 570).

The act referred to reads:

*   *   *   *   *   *   *

SEC. 2. That the park system of the District of Columbia is hereby placed under the exclusive charge and control of the Chief of Engineers of the United States Army, under such regulations as may be prescribed by the President of the United States, through the Secretary of War.

The said park system shall be held to comprise:

(*a*) All public spaces laid down as reservations on the map of eighteen hundred and ninety-four accompanying the annual report for eighteen hundred and ninety-four of the officer in charge of public buildings and grounds.

(*b*) All portions of the space in the streets and avenues of the said District, after the same shall have been set aside by the Commissioners of the District of Columbia for park purposes.

Provided, That no areas less than two hundred and fifty square feet between sidewalk lines shall be included within the said public system and no improvements shall be made in unimproved park spaces in streets between building lines or building lines prolonged until the outlines of such portions as are to be improved as parks shall have been laid out by the Commissioners of the District of Columbia: *And provided further*, That the Chief of Engineers is authorized temporarily to turn over the care of any of the parking spaces included in Class B above to private owners of adjoining lands under such regulations as he may prescribe and with the condition that the said private owners shall pay special assessments for improvements contiguous to such parking under the same regulations as are or may be prescribed for private lands.

The error referred to occurs in the sentence which reads:

And provided further, That the Chief of Engineers is authorized temporarily to turn over the care of any of the parking spaces included in Class B above to private owners, etc.

and consists in the fact that Class B should read Class A, because it is the reservations mentioned in Class A whose care is intended to be turned over temporarily to private owners of adjoining lands, and not those in Class B. It is therefore recommended that Congress be requested at its next session to correct the error in question by suitable legislation.

PARK CURBING.

It being the wish of Congress that the public parks should be as open as possible, all the former high iron fences have been removed, except where absolutely needed. This has left the edges of the parks with an unfinished appearance, which in many cases is very unsightly.

It has been found by experience that a simple stone curbing gives a pleasing finish, and is sufficient to preserve a neat border line between park and sidewalk. Lafayette Park is an illustration.

Franklin Park, one of the prettiest and most frequented in Washington, suffers for lack of this. A simple but tasteful curb can be laid around it for $2,000, and the appropriation of that amount is respectfully urged.

PARK WATCHMEN.

I especially desire to invite attention to the force of park watchmen, which force is improperly named, inadequate in point of numbers, and insufficiently paid. The designation of watchmen does not describe the members of this force and their duties. They are strictly policemen, with all the powers of the regular police force, and their duty is to maintain proper police control over the parks. This requires a great deal of delicacy on the one hand in dealing with women and children, and on the other the roughest and most dangerous kind of police work in dealing with toughs and offenders of all kinds. The duty of the men is not simply to watch the parks, but is also to protect the respectable people, especially women and children, in their full enjoyment, and unmolested by bad men and dissolute women. It would be a satisfaction to the men of the force and aid them in the performance of their duties to be designated as policemen, for offenders are sometimes averse

to being cautioned by watchmen, and question the authority of a watchman to make an arrest, as it is generally supposed that no one but policemen have authority to do so. In all the large cities of the country of which I have knowledge men doing similar duties are designated as park police, and it is therefore recommended that instead of park watchmen this force be henceforth called park policemen in all appropriation bills and reports.

The force is inadequate in point of numbers, and it is urged that an additional sergeant and 11 men be added to it. The one sergeant in charge of the force is overworked. During the day he has to ride on his bicycle over the whole city, inspecting every watchman and also inspecting the outlying reservations not looked after by watchmen. He has to come to this office every morning to make his report and receive instructions. He has to spend several hours a day at the police court several times a week, and in addition he has to inspect the night watchmen in the parks three times a week. There should be a second sergeant to assist him.

Many of the most important parks have but one watchman who patrols them but eight hours out of the twenty-four. These watchmen have in addition from five to twenty outside reservations to look after, some of them nearly a mile distant. Their hours of duty are generally from 8 a. m. to noon, and from 4 p. m. to 8 p. m. It is just as necessary to have these parks patrolled from noon to 4 p. m. and from 8 to 12 p. m. as at any other hours. During the off hours park loafers take advantage of the absence of the watchmen to do about as they please and subject respectable people to annoyance.

A new schedule is submitted of the park watchmen, or more properly, park policemen, required, which it is recommended be adopted and provided for. This new schedule increases the number of men from thirty-one to forty-two, with a first and second sergeant in addition:

Parks.	Present schedule.	Proposed new schedule.
General supervision	One sergeant	One sergeant, one assistant sergeant.
Franklin Park	One day watchman	One day watchman, one night watchman.
Lafayette Park	do	Do.
Smithsonian grounds	Two day watchmen, two night watchmen.	Two day watchmen, two night watchmen.
Judiciary Park	One day watchman, one night watchman.	One day watchman, one night watchman.
Lincoln Park	One day watchman	Do.
Iowa circle	do	Do.
Thomas circle	do	Do.
Washington circle	do	Do.
Dupont Circle	do	Do.
Farragut and McPherson parks.	do	Do.
Stanton Park	do	Do.
Henry and Seaton parks.	Two day watchmen, two night watchmen.	Two day watchmen, two night watchmen.
Mt. Vernon Park	One day watchman	One day watchman, one night watchman.
Greenhouses and nursery.	do	Do.
Grounds south of Executive Mansion.	Two day watchmen, one night watchman.	Two day watchmen, one night watchman.
Garfield Park	One day watchman, two night watchmen.	One day watchman, two night watchmen.
Monument Park	One day watchman, one night watchman.	One day watchman, one night watchman.
Potomac Park	do	Do.

QUALIFICATIONS AND PAY.

The park watchmen are selected from a special list prepared by the Civil Service Commission, which guarantees men of experience and very high qualifications. Notwithstanding this the Washington park watchman is probably the poorest paid man in the United States who has police duty to perform. He has practically the same duties as the Metropolitan police; the same intelligence and physical qualifications are required of him; his moral character must be good; his discipline is much the same; he has as many arrests to make as the average policeman; he runs the same risks as to injury from vicious people as the man doing duty on the street; his duties are more exacting, as half of his duty hours are spent in cautioning people about violating the rules of the park and in looking after children; he has a uniform to buy once a year in order to look neat; yet the pay of these watchmen is only $60 per month. The District government requires the street railway companies to pay their crossing police officers $75 per month for a great deal less exacting and laborious duty. The lowest grade on the Metropolitan police force receive $75 per month, and the officers who serve five or six years faithfully receive $90 per month. Moreover, if they are injured in the line of duty, or become unfit for service through sickness, or complete a certain number of years of faithful service, they are placed on the retired list with an allowance of from $40 to $50 per month from the fund toward which the park watchmen so largely contribute—that is, from fines and forfeitures of collateral from cases brought before the police court by them. These benefits they do not receive, and there is nothing for the park watchman to look forward to if he happens to be injured in the performance of his duty so as to make him unfit for further service, or if, after years of faithful performance of duty, he becomes too old longer to perform police duty.

It is earnestly recommended that the following schedule of pay be adopted for the force:

First sergeant in charge, per annum	$1,000
Second sergeant, per annum	900
Men, per annum	840

It is also recommended that the necessary legislation be adopted providing that all fines and forfeitures of collateral from cases brought before the police court by United States park police shall be held and reserved for the benefit of the United States park police under rules similar to those now in force for the Metropolitan police of the city.

Arrests made by United States park watchmen in the public grounds from July 1, 1902, to June 30, 1903.

Month.	Nature of offense.										
	Violating bicycle regulations.	Fast driving.	Disorderly conduct.	Trespass.	Drunks.	Throwing missiles.	Vagrancy.	Indecent exposure.	Larceny from the person.	Indecent assault.	Fast automobiles.
1902.											
July	15	3	6	20	2	......	3	1	......	1	3
August	11	1	14	17	5	......	4	3	......	......	1
September	11	8	11	6	4	1	8	3	......	......	......
October	9	7	7	6	2	1	7	2	1	1	5
November	9	4	8	4	2	4	2	......	......	......	......
December	2	3	4	1	2	......	1	......	......	1	1
1903.											
January	13	......	2	5	1	......	1	1	......	......	......
February	7	......	4	1	1	1	2	2	......	......	......
March	3	2	6	3	4	......	1	1	1	......	......
April	3	1	9	4	2	......	5	2	......	1	......
May	3	4	30	10	2	1	7	3	......	......	......
June	2	4	13	10	2	......	2	4	......	......	......
Total	88	37	114	87	29	8	43	22	2	4	10

Month.	Nature of offense.									Total number of arrests.
	Assaults and affrays.	Disorderly assembly.	Violating section II, park regulations.	Insane.	Peddling.	Cruelty to animals.	Violating hack regulations.	Carrying concealed weapons.	Deserter from the U. S. Navy.	
1902.										
July	1	2	1	......	......	......	......	......	......	58
August	......	2	2	......	......	1	......	......	......	61
September	1	......	......	......	......	......	4	......	......	57
October	1	1	......	......	16	......	1	......	......	67
November	......	1	1	......	......	1	2	......	......	38
December	......	3	1	......	......	......	......	......	......	19
1903.										
January	1	1	2	......	......	......	......	......	......	27
February	......	......	3	......	......	......	......	......	......	21
March	1	......	......	......	5	......	......	......	......	27
April	......	5	......	......	......	......	......	......	......	32
May	1	......	......	1	......	......	......	1	......	63
June	3	......	1	......	2	......	......	......	1	44
Total	9	15	11	1	23	2	7	1	1	514

Arrests made by United States park watchmen in the public grounds from July 1, 1902, to June 30, 1903—Continued.

Month.	Disposition of cases.											Record of fines.		
	Personal bonds taken.	Sent to workhouse.	Dismissed.	Insane; taken care of by Metropolitan police department.	Drunks; released when sober.	Children's guardians.	Returned to Navy Department.	Nolle prossed.	Forfeited collateral.	Number fined.	Total number of cases.	Total amount of collateral forfeited.	Total amount of fines collected.	Total amount of fines collected and of collateral forfeited.
1902.														
July	5	3	1	.....	2	....	....	...	37	10	58	$158.00	$81.00	$239.00
August	13	4	...	.....	5	....	....	...	23	16	61	105.00	110.00	215.00
September	8	5	1	.....	4	....	....	...	32	7	57	146.00	45.00	191.00
October	7	6	2	.....	2	....	....	...	44	6	67	395.00	26.00	421.00
November	6	1	...	1	2	....	....	...	21	7	38	71.00	41.00	112.00
December	2	1	1	.....	2	....	....	...	9	4	19	49.00	26.00	75.00
1903.														
January	1	2	...	.....	1	....	....	...	16	7	27	39.00	63.00	102.00
February	2	1	...	.....	1	....	....	...	16	1	21	99.00	5.00	104.00
March	2	3	...	.....	4	....	....	...	13	5	27	63.00	23.00	86.00
April	5	4	1	.....	2	....	....	2	15	3	32	59.00	20.00	79.00
May	5	8	...	1	2	1	....	...	22	24	63	90.00	187.00	277.00
June	3	2	2	.....	2	....	1	...	16	18	44	78.00	191.00	269.00
Total	59	40	8	2	29	1	1	2	264	108	514	1,352.00	818.00	2,170.00

CHILDREN'S PLAYGROUNDS.

This is a subject to which I desire to invite special attention. Persons interested in the well-being and development of the inhabitants of cities are seeing more and more clearly the necessity of providing places where children and young people can take exercise and find innocent recreation, and the great value thereof in developing health of body and mind in the citizens of the future. Wherever playgrounds have been provided the beneficial results have been immediately manifest.

A suitable playground draws children by the hundreds from streets and alleys where their occupations and amusements are of more or less questionable character, and brings them together, where, under the care and control of suitable persons, they can indulge in pleasant, innocent, and interesting exercises, competitions, and games. Many cities are quite advanced in this particular matter, and some have expended vast sums of money in providing these playgrounds and breathing spots where their crowded inhabitants can get a little relief. The desirability of public playgrounds in Washington has been recognized by Congress to a limited extent, as shown by the two laws on the subject.

Act of Congress, approved August 30, 1890 (Stat. L., 26, p. 396):

The officer in charge of public buildings and grounds may authorize the temporary use of a portion of the Monument grounds or grounds south of the Executive Mansion or other reservations in the District of Columbia for a children's playground, under regulations to be prescribed by him.

Act approved March 2, 1895 (Stat. L., 28, p. 943):

The officer in charge of public buildings and grounds shall authorize the use of a portion of the ground within the circle south of the Executive Mansion for a children's playground, under regulations to be prescribed by him.

Under the authority granted a playground was set aside between B street north and the main drive north of the Washington Monument. This contains about 8 acres, and is in use every pleasant day.

Act approved March 3, 1903 (Stat. L., 32, part 1, p. 1122):

The officer in charge of public buildings and grounds may hereafter authorize the temporary use of the Monument grounds or grounds south of the Executive Mansion or other reservations in the District of Columbia for playgrounds for children and adults, under regulations to be prescribed by him.

Under the additional legislation granted by the act last named, a large number of permits have been granted each month to play baseball upon that portion of the Monument grounds already set aside as a playground. In fact, requests for these permits have come from more organizations and aggregations of individuals than could be accommodated at any one time on the area available for the purpose.

Several years ago reservation 126, at the junction of Georgia and Virginia avenues and L street, between Ninth and Eleventh streets SE., was graded, and has been allowed as a playground since. Reservation 19, between K and L and Fifth and Seventh streets SE., was allowed to be used for ball playing until it was shown to be too small for the purpose. On some of the smaller reservations croquet has been permitted. While there are not many parks or reservations where baseball or football or other games requiring much space can be permitted, there are numbers where the area is adequate for the installation of the simple apparatus needed in a playground for small children.

It is respectfully submitted that permission to use these reservations and public grounds is not sufficient. An appropriation should be made for fitting them up, and every year the necessary appropriations should be made for their care, extension, and renewals as apparatus is worn-out or broken. I do not believe that there is any other way in which a small amount can be expended which would do more good or give greater pleasure or result in more lasting benefit than money appropriated and expended for fitting up, caring for, and maintaining children's playgrounds. Some small playgrounds have been established on private property with money subscribed by the generous people of Washington, but the matter needs a far more general, vigorous, and immediate treatment than is possible on the subscription basis.

I would therefore recommend that an appropriation of $10,000 be made for establishing, maintaining, and caring for children's playgrounds on public reservations in Washington, and authority given this Office to erect or permit the necessary structures thereon. I beg, furthermore, to invite attention to a report on public playgrounds by Mr. George H. Brown, landscape gardener, which is appended hereto as Appendix B, and which contains much interesting matter and valuable information.

MAINTENANCE OF IMPROVED PARKS.

The usual work required for maintaining the improved parks and park spaces in good condition was extended during the year. This work consists of mowing and raking lawns, edging their borders, sodding or seeding bare places on them, planting and caring for flower beds, pruning trees and shrubs, cleaning gutters and draintraps, and sweeping paved roads and walks.

In addition to the foregoing, the following work was accomplished:

NORTHWEST DIVISION.

Dupont Circle.—Worn places in the asphalt walks were repaired, the area resurfaced amounting to about 108 square yards. The interior and exterior of the lodge, 2 drinking fountains, 15 lamp-posts, 6 lamps, and the iron post-and-chain fence, consisting of 131 posts and 1,032 feet of chain, were painted.

Farragut Park.—Worn places in the asphalt walks were repaired, the area resurfaced amounting to 236 square yards; 162 square yards of sod were used for resodding bare places on lawns, 1 drinking fountain, 2 lamps, 8 lamp-posts, and the post-and-chain fence around the park, consisting of 130 posts and 995 feet of chain, were painted.

Franklin Park.—Repairs were made to the asphalt walks, the area resurfaced amounting to 95 square yards; 313 feet of 6-inch wrought-iron drainpipe were laid to drain catch-basins, and 2 new catch-basins were built, all for surface drainage. Draintraps and portions of the brick gutters were repaired, old iron frames and grates on the latter having been replaced with new ones; 1,890 square yards of sod were used in resodding bare places on lawns, the interior of the watchman's lodge, 2 drinking fountains, 2 lamp-posts, and 2 lamps were painted; 6 decayed trees were removed.

Iowa Circle.—The watchman's lodge, 6 lamp-posts, 6 lamps, and 2 drinking fountains were painted. Repairs were made to the asphalt walks, the area resurfaced amounting to 400 square yards. An ornamental cement coping 7 inches high and 8 inches wide, with corner posts at the entrances to walks, was constructed around the circle, the total length of the coping being approximately 1,064 feet and the number of corner posts 40. A cement coping of smaller dimensions, 4 inches wide and 2 inches high above the walk surfaces, was constructed on either side of all the asphalt walks running through the circle, the approximate length of the entire coping being 2,390 feet. A contract was also entered into on June 18, 1903, for the construction of a coping of red granite around the mound at the base of the pedestal of the statue of General Logan in this circle, the work to be completed by the middle of August, 1903.

Judiciary Park.—Two paved spaces (aprons), one with asphalt blocks and the other with Belgian blocks, in front of the coal vaults on north side of the court-house were enlarged to afford more room for the turning of coal carts and wagons without injuring the lawns. The ground on the south front and the east and west fronts of the Pension Office building, which had been disturbed by the construction of an area way around the building, was graded and sodded, and the adjacent walks and roadways graveled, the cost of the labor employed in doing the work having been paid by the Department of the Interior with funds retained from amounts due the contractor for the area way. An asphalt pavement, 216 feet long and 5 feet wide and covering an area of 120 square yards, was constructed on the gravel walk leading from Third and E streets NW. up to the court-house. Broken and worn places in the old asphalt walks were repaired, the area resurfaced amounting to 360 square yards; 51 feet of 6-inch wrought-iron drainpipe were laid to drain catch-basins.

Lafayette Park.—An asphalt pavement 137 feet long by 4 feet wide

and covering an area of 51 square yards was laid on the two walks leading to the closets in the lodge house, brick on edge set along the sides of the walks, and two small spaces east and west of the closets paved with brick. There was also constructed an asphalt pavement about 453 feet long and 5 feet wide and covering an area of 352 square yards on the walk from the Sixteenth and H street entrance to the north side by the watchman's lodge to Fifteen-and-a-half street (Madison place) on the east side. Repairs were made to all worn places in the old asphalt walks, the area resurfaced amounting to 900 square yards. Two old street washers were replaced with standpipes and hose valves, and the water service was extended by laying 281 feet of 1¼-inch galvanized-iron pipe. Four new brick drain traps were constructed, and 32 feet of 4-inch cast-iron drain pipe and 324 feet of 6-inch cast-iron drain pipe laid for carrying off surface water, and 136 feet of 6-inch terra-cotta pipe run to drain the east drinking fountain. Two hundred and sixteen square yards of sod were laid on bare places on lawns, and the iron railing around the Jackson statue, 4 lamp-posts, 4 lamps, and two drinking fountains were painted.

The appropriation of $1,000 for Lafayette Park is not enough to keep it in the condition in which it should be kept. This is the most highly improved and the most centrally situated small park in the city, and is seen and used by more people than any other. It is respectfully urged that the appropriation for this park be the same as for Lincoln Park, namely, $2,000 per year.

McPherson Park.—Repairs were made to the asphalt walks, the area resurfaced amounting to 400 square yards. Ninety square yards of sod were used in resodding bare places on lawns; 2 drinking fountains, 2 lamp-posts, and 2 lamps and two plant vases were painted.

Mount Vernon Square.—In October, 1901, this Office recommended to the Chief of Engineers that an estimate be submitted to Congress for an appropriation of $25,000 "for grading, resetting street curb, providing park curb, park walks, planting, and for each and every object necessary for highly improving the grounds of Mount Vernon Square around the Public Library building." In sundry civil appropriation act for the fiscal year ending June 30, 1903, approved June 28, 1902, Congress appropriated only $10,000 for the work. With that amount it has been possible only to grade the grounds, seed the level portions, sod the slopes, and provide for and mostly construct immediate approaches of the south and north entrances, leaving the granite borders, granolithic pavement, etc., still to be provided for. A careful estimate of the cost of the work which should be done to complete the improvement gives a sum total of $13,000, and it is earnestly recommended that that amount be appropriated. If that sum be granted, it will make the total cost of the improvement $23,000, which is $2,000 less than the original estimate.

Presidents Park.—Lines of asphalt blocks were laid across the end of the gravel roadway where it joins the asphalt pavement of West Executive avenue, in the northwest corner of the grounds, and 48 loads of gravel were used in repairing worn places in the gravel roads. The 50-foot gravel roadway running around the southeast, south, and southwest sides of the inclosed grounds of the Executive Mansion was covered with broken trap rock and trap-rock screenings to a depth of about 6 inches and rolled with a heavy steam roller, the area resur-

faced amounting to 7,960 square yards. A new cement floor was laid in the tool house at the corner of Seventeenth and B streets NW.

Rawlins Square.—Two old iron boxes around shut-off valves and two old standpipes in the fountain were replaced with new ones, and 280 feet of 4-inch cast-iron drain pipe were run to carry off waste water from the fountain.

Sheridan Circle.—Water was introduced into this circle, 206 feet of 2-inch pipe and 8 feet 8 inches of 1¼-inch galvanized-iron pipe having been laid for the purpose.

Truxton Circle.—The large fountain was scraped, cleaned, and painted.

Washington Circle.—Ten lamps and lamp-posts, 2 drinking fountains, and 4 flower vases were painted. On January 3, 1903, during the temporary absence of the watchman, some defect in the gas heater or its tubing in the lodge house started a fire which did some damage to the woodwork, broke some glass in the windows, and blistered the paint in the interior. Necessary repairs were made immediately to the woodwork, the broken glass replaced with new glass, and the lodge repainted.

Reservations 22, 23, 24, 25, 27, 28, 29, and 30, Pennsylvania avenue, between Nineteenth and Twenty-eighth streets NW.—The post-and-chain fences inclosing these reservations, a total of 407 posts and 3,242 feet of chain, were painted.

Reservation 31, Pennsylvania avenue, Eighteenth and H streets NW.—The post-and-chain fence inclosing this reservation, consisting of 86 posts and 650 feet of chain, was painted, and 54 square yards of sod was used in sodding bare places on lawns.

Reservation 32, Pennsylvania avenue, Fourteenth and E streets NW.—Depressions in the asphalt walks were repaired, an area of 5 square yards having been resurfaced. The vitality of the soil on this reservation having been destroyed by the fire which consumed the power house opposite the reservation on September 29, 1897, the old soil was removed, replaced with new soil, and the entire surface of the reservation resodded, 1,232 square yards of sod having been used for the purpose.

Reservation 33, Pennsylvania avenue, Thirteenth and E streets NW.—The entire asphalt walk surface in this reservation, an area of 530 square yards, was resurfaced.

Reservations 34 and 35, Pennsylvania avenue, between Eighth and Tenth streets NW.—The post-and-bar fences inclosing these two reservations, consisting of 94 posts and 752 feet of bars, were painted and the surface of reservation 35 was resodded.

Reservations 58, 59, 62, and 64, Massachusetts avenue, between Fifteenth and Twenty-first streets NW.—The post-and-chain fences inclosing these four reservations, consisting of 203 posts and 1,560 feet of chain, were painted.

Reservation 68, Massachusetts avenue and L street, between Eleventh and Twelfth streets NW.—A new cement sidewalk was constructed by the District government around this reservation and made 4 feet narrower than the old pavement. The reservation was extended out 4 feet on the Massachusetts avenue side for its full length of 276 feet, and the post-and-chain fence and 2 lamp-posts moved out to the new pavement line. As the grade of the new pavement had been raised, the grade of the reservation along the Massachusetts avenue front for

a width of 14 feet was raised and the ground resodded. The asphalt walk was extended out to the pavement line and about 10 square yards of new walk laid. Two small places around the drinking fountain were paved with brick. An ornamental iron fountain was erected and 142 feet of 1¼-inch galvanized-iron water pipe and 220 feet of 4-inch cast-iron drain pipe laid for its service. The post-and-chain fence, consisting of 49 posts and 394 feet of chain, 5 lamp-posts and lamps, 2 drinking fountains, and the new iron fountain, were painted.

Reservations 69, 70, 71, 72, and 74, Massachusetts avenue, between Fourth and Eleventh streets NW.—The post-and-chain fences inclosing these five reservations, consisting of 274 posts and 2,266 feet of chain, were painted, and 1 drinking fountain, 1 vase, 5 lamp-posts and lamps were also painted. Water was introduced into reservation 70 by laying 23 feet of 1-inch lead pipe and 36 feet of 1¼-inch galvanized-iron pipe.

Reservation 73, Massachusetts avenue, Fifth and L streets NW.—A post-and-chain fence, consisting of 13 posts and 216 feet of chain, was erected and painted.

Reservations 75 and 76, Massachusetts avenue, between Third and Fourth streets NW.—The post-and-bar fences inclosing these two reservations, consisting of 114 posts and 912 feet of bars, were painted.

Reservation 78, Massachusetts avenue and F street, between North Capitol and First streets NW.—The post-and-chain fence inclosing this reservation, consisting of 34 posts and 316 feet of chain, was painted.

Reservations 98, 99, 100, 102, and 134, Virginia avenue, from Twenty-second and E streets NW., to New Hampshire avenue, Twenty-fifth, and G streets NW.—The District government having narrowed the sidewalks around these five reservations, the post-and-chain fence inclosing them was moved out by this office 4 feet to the inner lines of the new sidewalks. As this increased the length of the boundary lines, it was necessary to increase the length of the fences and 28 posts and 259 feet of chain were added. The new borders of the reservations were also sodded, 1,017 square yards of sod having been used for the purpose.

Reservations 149 and 150, Connecticut avenue, between Eighteenth and Twentieth and M and R streets NW.—The post-and-chain fences inclosing these two reservations, consisting of 85 posts and 700 feet of chain, were painted. An ornamental iron fountain was erected in reservation 150, and 25 feet of 1¼-inch galvanized water pipe and 70 feet of 4-inch cast-iron drainpipe run for its service.

Reservation 150a, Connecticut avenue, Eighteenth and N streets NW.—Water was introduced for irrigating purpose, 28 feet of 1-inch lead pipe and 7 feet of 1¼-inch galvanized pipe having been laid.

Reservations 151, 154, 156, 157, 158, and 159, Rhode Island avenue, between Seventh and Eighteenth streets NW.—The post-and-chain fences inclosing these seven reservations, consisting of 189 posts and 1,364 feet of chain, were painted. A border of sod 2 feet wide was laid around reservation 158.

Reservation 155, Rhode Island avenue, Tenth and Q streets NW.—A post-and-chain fence, consisting of 21 iron posts and 173 feet of chain, was erected around the reservation and painted, the ground was graded, surface soiled, and a border of sod laid. Water was introduced by laying 95 feet of 1-inch lead pipe and 17 feet of 1¼-inch galvanized iron pipe.

Reservation 157, Rhode Island avenue, Ninth and Q streets NW.—The ground was regraded, soil spread on low places, grass seed sown, and a border of sod 2 feet wide laid on the margins. Seven small unsightly trees were removed. One additional post was set in the post-and-chain fence and the chain tightened.

Reservation 159, Rhode Island avenue, Sixth and R streets NW.—This reservation, which had previously been improved, was inclosed with an iron post-and-chain fence, requiring 49 posts and 394 feet of chain. The fence was painted.

Reservation 160, New Jersey and Rhode Island avenues and R street, between Fourth and Fifth streets NW.—The surface was regraded, the boundary line on the R street side extended out 5 feet, and a post-and-chain fence, consisting of 27 iron posts and 117 feet of chain, erected. The fence was painted.

Reservation 164, Vermont avenue and Thirteenth street, between P and Q streets NW.—The post-and-chain fence inclosing this reservation, consisting of 20 posts and 161 feet of chain, was painted.

Reservation 165, Vermont avenue and Twelfth street, between Q and R streets NW.—This reservation, which had previously been improved and planted, was inclosed with a fence of 29 iron posts and 231 feet of chain.

Reservation 166, Vermont avenue and Twelfth street, between R and S streets NW.—A fence, consisting of 22 iron posts and 183 feet of chain, was erected around this reservation.

Reservations 172, 173, 174, 176, and 177, New York avenue, between Fifth and Thirteenth streets NW.—The post-and-chain fences inclosing these five reservations, consisting of 242 posts and 1,931 feet of chain, were painted.

Reservation 175, New York avenue, Ninth and K streets NW.—The post-and-chain fence inclosing this reservation, consisting of 42 posts and 336 feet of chain, was painted.

Reservation 178, New York avenue and L street, between Fourth and Fifth streets NW.—The iron posts of the fence on the north side of this reservation having been thrown out of line by the settling of the ground, they were lifted and reset and the brick pavement of the sidewalk put in order. Seventy square yards of sod were used in laying a border of sod 2 feet wide along the line of posts. The post-and-chain fence, consisting of 50 posts and 410 feet of chain, was painted.

Reservation 179, New York avenue and M street, between New Jersey avenue and Fourth street NW.—The iron railing fence inclosing this reservation was painted.

Reservation 182, New York avenue and N street, between First and North Capitol streets NW.—Iron chain was run through the iron fence posts which had been erected around this reservation in May, 1902.

Reservations 187, 188, and 189, Louisiana and Indiana avenues, from Second to Sixth streets NW.—The post-and-chain fences inclosing these three reservations, consisting of 168 posts and 1,330 feet of chain, were painted.

Reservations 190 and 192, New Jersey avenue, between Third and Fourth streets, NW.—Iron chain was run through the iron posts which were erected around these two reservations in May, 1902, and the fences, consisting of 117 posts and 881 feet of chain, were painted.

Reservations 193, 194, and 196, New Jersey avenue, between E and K

streets NW.—The post-and-chain fences inclosing these three reservations, consisting of 123 posts and 924 feet of chain, were painted.

Reservation 195, New Jersey avenue and First street, between G and H streets, NW.—A gravel walk, 80 feet long and 6 feet wide, was constructed at the base of the reservation for a passageway across the reservation from New Jersey avenue to First street. The location of the watchman's lodge was changed to suit this improvement. The post-and-chain fence inclosing this reservation, consisting of 67 posts and 560 feet of chain, was painted.

Reservation 270, Connecticut and Florida avenues and Twenty-first and S streets, NW.—Water was introduced by laying 44 feet of 1-inch lead pipe and 12½ feet of 1¼-inch galvanized-iron pipe.

Reservation 275, Florida and New Jersey avenues and S street, between Fourth and Fifth streets, NW.—This reservation, hitherto unimproved, was partially improved during the year. The ground was graded, covered with good soil, a border of sod laid, an iron post-and-chain fence, consisting of 14 posts and 112 feet of chain, erected, and the fence painted.

Reservation 276, Florida avenue and R street, between First and Third streets, NW.—Iron chain was run through the posts which were erected around this reservation in May, 1902, and the fence, consisting of 14 posts and 112 feet of chain, painted.

Reservation 277, Florida avenue and Q street, between North Capitol and First streets, NW.—Iron chain was run through the posts which had been erected around this reservation in May, 1902.

SOUTHWEST DIVISION.

At the request of this office the District government laid an asphalt crossing pavement over Seventh street near B street SW., to connect the park roadway in Henry Park with that in the Smithsonian grounds, also one over Twelfth street near B street SW., to connect the park roadway in the Smithsonian grounds with that in the grounds of the Agricultural Department.

In June, 1903, that portion of the grass in Henry Park, Monument Park, and the Smithsonian grounds that had been permitted to grow high for the purpose was cut and made into hay for use of the public animals.

Henry Park.—Sixty linear feet of stake-and-wire fencing were erected to prevent trespassing on lawns and 162 square yards of sod were used in resodding bare places. Twenty cartloads of gravel were used in repairing walks. Twenty lamp-posts and lamps were painted. In December 518 feet of board walk 2 feet wide were laid on paths in the north end of the park, which were rough and wet during the winter months.

Monument Park.—About 130 cubic yards of gravel were used in repairing the main roadway on the west side of the grounds entering from Sixteenth and B streets NW.

Seaton Park.—Seventy linear feet of stake-and-wire fencing were erected to prevent trespassing on lawns. Repairs were made to gravel walks, 52 evergreen trees were removed from overcrowded groups, and the watchman's lodge and 23 lamps and lamp-posts were painted.

Smithsonian grounds.—Worn places in the asphalt roads and walks were repaired, the area resurfaced amounting to 1,026 square yards;

504 square yards of sod were used in resodding bare places on lawns; 60 cubic yards of broken stone and brick and 47 cubic yards of gravel were used in repairing gravel roadways. Three dead trees were removed. A small frame building formerly used in the White House grounds was removed therefrom to the Smithsonian grounds and placed at the entrance of one of the roadways from Twelfth street for use as a lodge, tool house, etc. Minor repairs were made to the building. The water service was extended by laying 520 feet of 2-inch galvanized-iron pipe and 200 feet of 1¼-inch galvanized-iron pipe, and a section of the 12-inch water main was cut out and a 12-inch gate valve inserted for controlling the water system of the park. The lodge house on the Seventh street side of the park, 76 gas lamps, and 2 drinking fountains were painted.

Attention is respectfully invited to the fact that there are in the Smithsonian grounds over 58 acres of land on which there are approximately 3,600 linear feet of asphalt roadway, 7,000 feet of gravel roadway, and 9,400 linear feet of walks. To keep this large park in proper condition—trees trimmed, grass cut, and roads and paths in good repair—there has been an appropriation of $2,500 yearly. This is not sufficient to do the work required, and it is respectfully recommended that it be increased to $3,500 per year.

Reservation 111, Virginia avenue and B street, between Eleventh and Twelfth streets, S W.—The post-and-chain fence inclosing this reservation, consisting of 67 posts and 543 feet of chain, was painted.

Reservation 112, Virginia avenue, Ninth and C streets S W.—Iron chain was run through the posts which had been erected around this reservation in May, 1902, and the fence, consisting of 46 posts and 378 feet of chain, was painted.

Reservation 202 (Garfield Circle), Maryland avenue and First street S W.—The curb around this circle having been reset by the District government and in some places lowered, the sod was removed at those places, the ground graded down, and the sod relaid.

Reservation 285, Canal and D streets, between Delaware avenue and First street, S W.—The post-and-chain fence inclosing this reservation, consisting of 61 posts and 485 feet of chain, was painted.

EAST DIVISION.

Folger Park.—The old wire fence around the fountain basin was removed and replaced with a new fence made of iron pipe and wire; 466 square yards of additional asphalt pavement were laid on gravel footwalks, and 184 square yards of sod were laid on the worn borders of lawns. The worn gravel walks and the gravel margins of the asphalt walks were resurfaced and rolled, 65 cubic yards of gravel having been used for the purpose.

Garfield Park.—Washouts in the gravel roads were repaired and portions of the gravel roads and walks were resurfaced and rolled, 105 cubic yards of gravel being used for the purpose. The District government constructed a public sewer through the park, and after completion of the work restored the ground disturbed in its prosecution by grading and sodding lawn surfaces, repairing gravel roads, and relaying cobblestone gutters. Trees were pruned, and 4 big, unsightly trees and 24 unsightly shrubs were grubbed out and removed. The District government made a survey to locate the line of Virginia avenue

through the park, and the Pennsylvania Railroad Company erected a tight board fence 8 feet high on the north curb line of Virginia avenue extended through the park from Third street SE. westward to South Capitol street, all of that portion of the park south of Virginia avenue extended through the park having been granted by Congress for the uses of the railroad company. The fence was erected by the company in order to protect that portion of the park which is left to the United States from being encroached upon and damaged by the laborers employed by the company in constructing its new system of trackage above and below grade. The watchman's lodge was moved 115 feet north of its former location, and 239 cartloads and 89 wagonloads of sod were cut from the ground to be occupied by the railroad company for use in other reservations, and 91 cartloads of good soil were also removed from the same ground and hauled to the storage grounds at Fifth and K streets SE. for future use.

The change in the grades of streets in this vicinity due to the railroad construction, and the change in the dimensions and shape of Garfield Park due to the same cause, will require an entirely new laying out of the park. It will have to be graded up to conform to the new grades of streets crossing it, trees taken out and new ones planted, and new park roads and walks constructed. This work can not all very well be done until the railroad operations are concluded, but by doing some of the work the park might be used as a spoil bank and all the filling accomplished without cost. By taking advantage of circumstances great economy will result. It is therefore recommended that an appropriation of $2,000 for Garfield Park be made for work required in it incident to the Pennsylvania Railroad operations.

Lincoln Park.—The old brick fountain basin on the north side of the park was replaced with an ornamental iron fountain and the gravel walk formerly around the old fountain was removed, soil spread, and the place sodded; 249 square yards of additional asphalt pavement were laid on gravel walks and repairs made to old asphalt walks, the area resurfaced amounting to 62 square yards. The old standpipe in the fountain basin was replaced with a new pipe; 16 lamp-posts, 5 lamps, and 2 drinking fountains were painted.

Marion Park.—Twenty-two cubic yards of gravel were used in repairing the gravel roadway through the park; 156½ square yards of additional asphalt pavement were laid on gravel walks; 103 square yards of sod laid, and 80 feet of wire fencing erected to prevent trespassing.

Seward Square.—By the act of Congress approved March 3, 1903, Public No. 167 (vol. 32, Stats., p. 1224), it is provided that "from and after the passage of this act the space formed by the intersection of C street south and Pennsylvania and North Carolina avenues from Fourth to Sixth streets east, in the District of Columbia, now commonly known as Seward Place, shall be officially known and designated as 'Seward Square.'" This space is at present divided by intersecting streets and avenues into six separate parcels of ground designated as reservations 38, 39, 40, 41, 42, and 43. During the year the old brick gutters on the north side of reservations 38, 39, and 41 were taken up and the spaces sodded.

Stanton Park.—Low places in the gravel walks were repaired with fresh gravel and the walks were rolled; 117 square yards of sod were used in resodding the borders of lawns; 337 square yards of addi-

tional asphalt pavement were laid on gravel walks and repairs were made to the old gravel walks, the area resurfaced, amounting to 156 square yards; 335 feet of cast-iron drainpipe were laid to drain the two fountains and one new draintrap was built. The iron post-and-chain fence, consisting of 193 posts and 1,551 feet of chain, was painted.

Reservations 37, 40, 42, 43, and 44, Pennsylvania avenue, between Second and Seventh streets, SE.—A new cement sidewalk was laid by the District government on the Pennsylvania avenue front of each of these five reservations, and in doing the work the borders of the reservations were disturbed, requiring them to be resodded, and that work was done at all those reservations by the park laborers.

Reservations 45 and 50, Pennsylvania avenue, between Sixth and Eleventh streets, SE.—The borders of these reservations were sodded, and the bare places in the lawn surface of reservation 45 were sown with grass seed.

Reservation 47, Pennsylvania avenue, Eighth and D streets, SE.—This reservation was graded and sodded with 90 square yards of sod. An iron post-and-chain fence, consisting of 16 posts and 145 feet of chain, was erected and the fence painted.

Reservation 81, Massachusetts avenue and E street, between First and Second streets, NE.—Two hundred and seventy feet of chain were run through the iron posts which had been erected around this reservation in April, 1902, and the fence was painted.

Reservation 82, Massachusetts avenue and D street, between Second and Third streets, NE.—Two hundred and eighty-nine feet of chain were run through the iron posts which had been erected in April, 1902, and the fence painted.

Reservation 84, Massachusetts avenue, Seventh and B streets, NE.—The iron post-and-chain fence inclosing this reservation, consisting of 50 posts and 450 feet of chain, was painted.

Reservation 86, Massachusetts avenue, Ninth and A streets, NE.—Five of the iron posts were removed from the street parking adjoining the reservation, two of them reset in line with the boundary stones, and the chain refastened.

Reservation 126, Virginia and Georgia avenues and L street, between Ninth and Eleventh streets, SE.—The two old hydrants in this reservation were replaced with new hydrants.

Reservations 203, 204, and 205, Maryland avenue, between First and Third streets, NE.—The iron post-and-chain fences inclosing these three reservations, consisting of 166 posts and 1,090 feet of chain, were painted.

Reservation 213, Maryland avenue, Fourteenth and G streets, NE.—This reservation was inclosed with an iron post-and-chain fence, 21 posts and 181 feet of chain having been used for the purpose. The fence was painted.

Reservation 224, Delaware avenue and First street, between E and F streets, NE.—The rustic stone coping and the pyramid center of the fountain basin were removed, and a portion of the stones hauled to Lincoln Square for use around the new fountain erected there. Reservation 224 is one of those donated by Congress to the Philadelphia, Washington and Baltimore Railroad as part of the site for the new Union Station.

Reservation 229, North Carolina avenue, First and E streets, SE.—

Four hundred and sixteen feet of chain were run through the iron posts which had been erected around the reservation in May, 1902, and the fence was painted.

Reservation 230, North Carolina avenue, Seventh and B streets, SE.—This reservation was partially inclosed with a wire fence to prevent trespassing.

Reservation 231, North Carolina avenue, Eighth and B streets, SE.—This reservation was inclosed with an iron post-and-chain fence, consisting of 16 posts and 127 feet of chain, and the fence was painted.

Reservation 232, North Carolina avenue and B streets, between Eighth and Ninth streets, SE.—The post-and-chain fence inclosing this reservation, consisting of 38 posts and 285 feet of chain, was painted.

Reservation 233, North Carolina avenue and A street, between Eighth and Ninth streets, SE.—The post-and-chain fence inclosing this reservation, consisting of 36 posts and 288 feet of chain, was painted. Water was introduced into the reservation.

Reservation 234, North Carolina avenue and A street, between Ninth and Tenth streets, SE.—The surface was graded, surfaced with soil, and sodded; a post-and-chain fence, consisting of 19 posts and 160 feet of chain, erected and painted, and water introduced.

Reservation 255, Georgia avenue, Fifteenth and G streets, SE.—This unimproved reservation was partially improved. The surface was graded, covered with top soil, grass seed sown, and a border of sod laid; a post-and-chain fence, consisting of 44 iron posts and 358 feet of chain, was erected and painted.

Reservation 266, Tennessee avenue, Thirteenth and B streets, NE.—A new stake-and-wire fence 110 feet long was erected around this reservation in place of the old one.

CARE OF TREES ON SIDEWALKS AROUND RESERVATIONS.

On May 28 the engineer commissioner of the District of Columbia suggested that this office take care of the tree spaces on sidewalks around United States public reservations under its charge, in connection with the care of the reservations themselves, and under date of May 29 he was informed it would do the best it could to look after them.

RESERVATIONS OCCUPIED FOR PURPOSES OF THE THIRTY-SIXTH NATIONAL ENCAMPMENT, GRAND ARMY OF THE REPUBLIC.

In Public Resolution No. 41, approved June 30, 1902 (vol. 32, Stats., p. 749, sec. 5), the Secretary of War was—

> authorized to grant permits to the citizens' executive committee for the entertainment of the Grand Army of the Republic for the use of any reservation or other public spaces in the city of Washington on the occasion of the thirty-sixth national encampment in the month of October, nineteen hundred and two, which, in his opinion, will inflict no serious or permanent injuries upon such reservation or public spaces or statuary therein.

Under this authority permits were granted by the War Department as follows:

September 10, 1902.—For the erection of two viewing stands on the south side of Lafayette Park.

September 13, 1902.—For the erection of tents and other structures in the White Lot (grounds south of the Executive Mansion) for reunion purposes, sleeping quarters, etc.

September 20, 1902.—For the erection of tents, scenery, paraphernalia, seats, and other structures on the Monument grounds for a display of fireworks.

September 20, 1902.—For the erection of tents on the northeast portion of the Monument grounds for sleeping quarters.

September 20, 1902.—For the erection of viewing stands, one on reservation 32, south side Pennsylvania avenue, between Thirteen-and-a-half and Fourteenth streets NW., and one on reservation 34, south side Pennsylvania avenue, between Ninth and Tenth streets NW.

September 29, 1902.—For the erection of tents on the northwestern corner of the White Lot for a division hospital.

In all of the foregoing cases bonds were given by the chairman of the proper committee for the restoration of the grounds to good condition after the close of the encampment.

A permit was also granted by this office, with the approval of the President, on September 25, 1902, for the erection of a "Presidential reviewing stand" on the sidewalk on the south side of Pennsylvania avenue in front of the middle of the White House grounds.

Under these permits the committee erected in September, 1902, the following:

Grounds south of Executive Mansion (*White Lot*).—On the ellipse, 5 large assembly tents, 1 platform, 1 flag pole, and 86 small tents around the edge of the ellipse for use as headquarters tents by the different army corps. On the Fifteenth street side, east of the ellipse, 54 tents for sleeping quarters, 2 post-office tents, and 3 press tents. On the Seventeenth street side, west of the ellipse, 90 sleeping tents. On the northwestern corner of the grounds, 45 tents for use as a division hospital. Six tents for water-closets were also erected, 2 in the ellipse, 1 on the Seventeenth street side, and 3 on the Fifteenth street side of the grounds, making 291 tents in all. Thirty electric-light poles were also erected, and temporary connections made for water.

Monument grounds.—On that part of the grounds north of the Monument and between the Fifteenth street roadway and Sixteenth street roadway, frame work and scenery, 15 tents, 7 ticket booths, 39 electric-light poles, and seats to accommodate about 20,000 persons were erected and inclosed with a wooden railing, all for the exhibition of fireworks, the area of ground occupied being 38,000 square yards. In the northeast part of the grounds 219 tents for free sleeping quarters, 1 toilet room, and 10 electric-light poles were erected, the area occupied amounting to about 19,000 square yards.

Lafayette Park.—Two large viewing stands on the south side, each with a seating capacity of 1,215 persons.

Sidewalk in front of White House grounds.—One Presidential reviewing stand with 1,000 chairs.

Reservation 32, south side Pennsylvania avenue, between Thirteen-and-a-half and Fourteenth streets N W.—A viewing stand with a seating capacity of 1,100 people.

Reservation 34, south side Pennsylvania avenue, between Ninth and Tenth streets N W.—A wooden booth for selling refreshments.

No permanent injury was done to the grounds by their occupancy for the foregoing purposes, but the provisions in the several permits that all structures were to be removed and the grounds restored by October 25, 1902, were not fully complied with, except in the case of the Monument grounds, from which park the structures were all removed by October 24, and the grounds cleaned and restored without

expense to the United States. On October 13 this office suggested to the chairman of the executive committee of the encampment that our park laborers perform the work necessary to restore the grounds to their former condition, the cost of the work to be defrayed by the committee. He replied, under date of November 10, that the committee had not only no funds in hand, but was actually behind in cash with which to pay bills. This office was therefore compelled to clean portions of the grounds at its own expense. Following is a brief summary showing when the grounds were vacated by the committee and the work done by this office in restoring them:

Grounds south of Executive Mansion (*White Lot*).—The removal of the structures was commenced by the committee October 10 and completed October 18. The grounds were afterwards cleaned and the débris removed by the park laborers at a cost to the United States of $150.

Lafayette Park.—The stands were taken down by the committee between October 10 and 25, but all the lumber was not removed until October 31. After the latter date the committee caused the débris to be removed, but this office was obliged to reclean the grounds at an expense to the United States of about $10.

Sidewalk in front of White House grounds.—The Presidential reviewing stand erected here was to have been removed not later than October 18. The work of tearing down the stand was commenced on the 17th (after a peremptory order had been given by this office for its demolition) and completed by the evening of the 18th, but the removal of the lumber and the dirt was not completed until October 31. All of this work was done by the committee without expense to the United States.

Reservation 32.—The removal of the viewing stand was commenced by the committee on October 10 and by the 17th all the materials had been removed from within the limits of the reservation.

Reservation 34.—The wooden booth for selling refreshments erected on this reservation was removed therefrom between October 10 and 17, without expense to the United States.

Henry Park.—A tent erected on the north side of the park for use of the bureau of information was removed by the committee immediately after the close of the encampment on October 13, after which the ground was cleaned by the park force in the regular course of work, with but small additional expense, of which no separate account was kept.

Recommendations.—It is recommended that hereafter when permission is granted by Congress for the temporary use of the public grounds for purposes similar to the foregoing, the persons to whom the privilege is granted be required, as a condition precedent to such use, to deposit with the officer in charge of public buildings and grounds an amount in cash which, in his judgment, may be sufficient to cover the cost of restoring the grounds to the condition in which they were previous to such occupancy, the work of restoring the grounds to be done by the park force employed under the said officer and the cost thereof to be paid by him out of said cash deposit, any balance remaining after said payments are made to be returned to the persons making the deposit.

POTOMAC PARK.

By authority of the Chief of Engineers United States Army, Lieut. Col. Charles J. Allen, Corps of Engineers, transferred to the charge of the office of public buildings and grounds, by letter dated August 12, 1901, the portion of Potomac Park between the tidal reservoir and the Washington Monument grounds and extending from Seventeenth street and Virginia avenue NW. to Maryland avenue and Fourteenth street SW. On October 30, 1901, this office submitted to the Department an estimate to be transmitted to Congress for an appropriation for improving the ground.

In sundry civil act approved June 28, 1902, Congress appropriated the sum of $70,000 for the work, and a project for the application of the funds was submitted to the Chief of Engineers under date of July 5, 1902, and approved July 10. This project provided for raising the revetment wall along the tidal basin 3 feet with concrete, adding to the masonry revetment wall where necessary, and building a macadam driveway with Telford base 50 feet wide, with cobble gutters and drains, traps, etc.

Work was commenced on July 14, 1902, and continued to June 30, 1903, except for a short time in the winter, when the weather was unfavorable for outdoor operations. Following is a description of the work done during the year:

Grading.—This work was done by hired labor. About 20,000 cubic yards of earth, ashes, etc., were excavated from those parts of the ground above grade and used in filling low portions. In addition, about 14,550 cubic yards of material were received without expense to the United States and used for the same purpose. The ground on either side of the new 50-foot roadway was graded for a width of 20 feet the entire length (about 4,350 feet) of the roadway. Nearly all of the rough grading on other parts of the ground has been completed. About 3,700 square yards of sod were laid as borders along the roadway and walk, etc., and finished lawn surfaces.

Roadway.—The roadbed of the 50-foot roadway has been graded for the entire length of the roadway (4,299 linear feet along center line) and prepared to receive the macadam pavement; 32 brick catch basins with iron grates have been built along the gutterways on the sides of the road and 1,116 feet of 6-inch terra-cotta drain pipe, 206 feet of 8-inch, 212 feet of 10-inch, 263 feet of 12-inch, and 236 feet of 18-inch laid to connect the basins with sewer. In addition to the grading of the 50-foot roadway, a piece of roadway 154 feet long and 39 feet wide has been constructed to connect the 50-foot roadway by a turn south of the propagating gardens with the Fifteenth street roadway in the Monument grounds at D street SW. One hundred elm trees were planted along the borders of the 50-foot roadway.

Macadam pavement and gutters.—On October 20, 1902, a contract was entered into for constructing a trap rock macadam pavement with Telford base of limestone, with stone gutters, on the 50-foot roadway, the length of the roadway being about 4,350 feet and the area of the pavement being, approximately, 21,550 square yards and the gutters 2,275 square yards. The Telford base has been laid on the roadway for a length of 3,750 linear feet, or 18,750 square yards. The roadway has been completed with the three top corners of trap rock and

trap-rock screenings for a length of 1,000 feet, including the gutters. The first course of trap rock and the gutters have been laid for a length of 800 feet additional.

This contract was to have been completed by April 30, 1903, but because of delays resulting from inability to get materials from the quarry, and because the work was suspended during the past winter by unfavorable weather, the time has been extended to August 1, 1903.

Bridle path and cinder walk.—The bridle path 17½ feet wide on the east side of the road and the cinder walk 8 feet wide on the west side have been completed for a length of 2,000 feet, commencing at the entrance at Seventeenth and B streets NW. and running thence south.

Old bathing beach.—In the act providing for the improvement of that portion of Potomac Park to which this report refers it was provided:

> That the authority given the Commissioners of the District of Columbia by act approved September 29, 1890, to construct a beach and dressing houses upon the east shore of the tidal reservoir against the Washington Monument grounds is hereby revoked; and they are directed to remove immediately said bath houses, floats, wharves, pipes, etc., either to such other point as may be agreed upon between them and the Secretary of War or to barges constructed to carry dressing rooms, which may be anchored at such point around an inclosed water space or along the shore as may be agreed on between the Secretary of War and the said Commissioners.

As soon as the buildings connected with the bathing beach were removed by the Commissioners, September 1, 1902, this office entered upon the ground vacated between the power house of the Washington Monument and the flushing basin, graded it, and laid out a large elliptical lawn surface upon it with a roadway 35 feet wide around it, connecting the 50-foot roadway along the east side of the basin with the main roadway on the west side of the Monument grounds. The ellipse has been sown in grass seed, its borders sodded, the first course of broken stone for a macadam pavement laid on the roadway, and gutters constructed. An iron post-and-chain fence was erected around the ellipse.

New revetment wall.—When the sea wall was constructed on the north and west sides of the flushing reservoir some years ago, before that portion of the park was transferred to the jurisdiction of this office, a gap about 478 feet in length south of the power house of the Washington Monument was left, only the foundation of riprap stone being built, in order that the bathing beach might be located there. In constructing the bathing beach those foundation stones were covered with sand. When the bathing beach was removed, in accordance with the act of Congress above referred to, proposals were invited—

First. For removing the sand from old foundation; and

Second. For constructing necessary additional foundation and building the wall to close the gap.

Only one proposal each was received for the two items. Work for removing the sand was commenced October 23, and completed November 6, no contract being necessary. The sand was removed from the old foundation for a length of about 500 feet and for about 2 feet down on either side thereof, the total quantity removed being, approximately, 2,000 cubic yards.

A contract for building the new wall was entered into November 7, work commenced November 8, and completed January 14, the work done consisting of the construction of 850 cubic yards of riprap foun-

dation, 193 cubic yards of dry masonry wall below the water line, and 236 cubic yards of masonry wall laid in cement mortar above the water line. Three hundred and fifty cubic yards of back filling was also done by the contractor for this wall.

Old revetment wall.—The height of the stone wall existing on the north and east sides of the tidal basin was 3 feet above mean high tide when that part of the park was transferred to this office. The approved project for the improvement of the park provided that the wall should be at least 6 feet high above mean high tide. Bids for raising the wall 3 feet were invited and were opened on September 15, 1902. All proposals received were considered excessive and were rejected. It was thereupon decided to do the work by hired labor, purchasing the materials under proposals received under competition, as being most advantageous to the Government—the new part of the wall to be constructed of Portland-cement concrete, as being most economical and equally as satisfactory as stone. The work of increasing the height of the wall was commenced under the above conditions on November 13, 1902, and completed April 18, 1903, no work being done in January and February, owing to the unfavorable weather. The work accomplished was the building of 2,749 linear feet of concrete wall on the old stone masonry wall 3 feet 2 inches, 3 feet 6 inches, and 3 feet 8 inches in height, and 2 feet 8 inches, 2 feet 9 inches, and 2 feet 11 inches wide, according as the height and width of the old wall varied. The total mass of the new concrete construction was 969 cubic yards and 23 cubic feet. Four-inch tile drain pipe was set in the wall every 5 feet, and 2,552 linear feet of blind drain of broken stone and brick was built along the inner side of the wall for draining the ground behind it. After the wall was completed the earth was graded up behind it to the proper height.

Entrance to Potomac Park.—On the west side of the entrance to the park at Seventeenth and B streets NW. stands an old 2-story stone building which was erected many years ago by the Chesapeake and Ohio Canal Company for use as a gate house by the keeper of the canal lock which was located at that point. The house was in a very dilapidated condition when this office assumed charge of the park, and was occupied by a family of negro squatters. Those people were requested to vacate the premises, and did so about the 1st of August, 1902. Through the efforts of this office the trustees of the canal company, by deed dated August 14, 1902, under authority granted them by the Supreme Court of the District of Columbia, conveyed to the Chief of Engineers, for the use of the United States, all its right, title, and interest in and to the building. It is the intention to use this house as a watchman's lodge and tool house, and accordingly, in May, 1903, work was commenced putting it in good repair. The old roof was removed and replaced with a new shingle roof, 4 new dormer windows were put in, the old floors removed, new floor joist laid on the second floor, a new floor put in, and new window sashes fitted. On the first floor new floor joists were put in and a new floor laid, 4 new windows put in, the room wainscoted, and a partition 18 feet long and 8 feet high erected.

Photographs.—Four photographs showing portions of Potomac Park before and after improvement accompany this report.

Completion of improvement.—To complete this portion of Potomac Park from Fourteenth to Seventeenth streets, more work is required

VIEW OF OLD CANAL LOCK HOUSE AT SEVENTEENTH AND B STREETS NW., ENTRANCE TO POTOMAC PARK, LOOKING SOUTHEAST (BEFORE THE IMPROVEMENTS), MAY, 1902.

(Lock house built in 1837.)

MAIN ENTRANCE TO POTOMAC PARK, SEVENTEENTH AND B STREETS NW. (BEFORE IMPROVEMENTS), WITH OLD CANAL LOCK HOUSE IN FOREGROUND, LOOKING SOUTHWEST. MAY, 1902.

(Lock house built in 1837.)

VIEW OF OLD CANAL LOCK HOUSE AND ENTRANCE TO POTOMAC PARK AT SEVENTEENTH AND B STREETS NW., LOOKING SOUTHEAST (AFTER IMPROVEMENTS).

(Lock house built in 1837.)

VIEW OF NEW ROADWAY, POTOMAC PARK, SHOWING POWER HOUSE, PROPAGATING GARDENS, AND TIDAL RESERVOIR, LOOKING SOUTHEAST.

than can be accomplished with the money provided. The eastern portion, between the new roadway and the propagating gardens, will have to be raised 2 to 3 feet, and much of the area embraced covered with soil for the growth of grass, and some will have to be sodded and the rest seeded; some additional drainage will have to be put in; about 2,000 feet of cinder path for sidewalk and 2,000 feet of cinder bridle path will be required; about 800 trees will also be needed to complete the tree planting required.

It is also very much desired that Fifteenth street, between the Bureau of Engraving and Printing and the propagating gardens from B street south to the new waterside drive, may be improved, as it is needed as the eastern approach to this new drive. This portion of Fifteenth street is not a city street, but a park road, and therefore its improvement must be provided for as a park improvement. This particular bit of work on Fifteenth street is needed that the greater waterside drive and improvement may be rendered pleasantly accessible and more useful.

To do all the work required of completing the improvement of this portion of Potomac Park and making the approach by Fifteenth street extended will cost, it is estimated, $20,000, and it is recommended that this amount be appropriated.

Proposed riverside drive.—That portion of the Potomac Park up the river from the tidal basin is now in a condition to be improved to a certain extent. While its entire area has not been filled to the desired extent, it has been filled about to the proper grade along the tidal basin and the riverside. It is therefore suggested and recommended that along the tidal basin and the river there be constructed a macadam carriage road and a walk, and that along the riverside from the inlet to the tidal basin to the foot of Twenty-sixth street there be constructed alongside the macadam carriage way a soft road where horses can be properly exercised and speeded. This carriage road, walk, and speedway will furnish a greatly needed addition to the public ways of the city. The Potomac River has never been accessible in a pleasant way to the people of the city and this proposed drive is intended to make it so. It will be readily reached from the foot of Seventeenth or Twenty-sixth streets, and will furnish a new, beautiful, and unique feature to the city drives. The soft roadway, or speedway, will be a comparatively inexpensive addition to the system which will be greatly appreciated by all owners and drivers of fine horses, and the exercising, driving, and speeding of these horses will be a source of pleasure, interest, and benefit to many thousands who love to see such sights. Nearly every important city in the country has built and maintains such a driveway somewhere within its borders, and whenever one has been built it has contributed so much to the pleasure and profit of the people that it is now regarded as an essential.

The estimated cost of this riverside drive with the approach along the west side of the tidal basin and at Twenty-sixth street west, sidewalk, speedway, trees, etc., is $160,000, and the appropriation of that amount is earnestly recommended.

PROPAGATING GARDENS, INCLUDING GREENHOUSES AND NURSERY.

One of the important and crying needs of the propagating gardens is a central heating plant. This must be quite evident when it is con-

sidered that there are at the gardens 30 greenhouses which are heated by 20 separate and distinct heating plants, consisting each of furnace and boiler, and each requiring to be attended to, fed, and cared for separately. The care of these separate plants requires much more labor than a single central plant doing the same work would, and the consumption of fuel is very considerably greater. As the price of fuel has gone up materially of late, and in all probability will go up more, all expedients tending to lessen its consumption should be adopted. In all private nurseries and collections of greenhouses similar to our propagating gardens, a central heating plant is used because of its greater economy and efficiency.

It is estimated that a central heating plant, housed in a neat, substantial, brick building, with room for boilers, coal, etc., together with the requisite piping for conveying steam to and through all the greenhouses, will cost about $25,000. The boilers should be in duplicate, as the collection of plants is of great value. There will be over 5 miles of steam-heating and conveying pipe required and the necessary appliances for controlling the steam and returning the water of condensation to the boilers. An appropriation of $25,000 is, therefore, in view of the above, requested and recommended for a central heating plant for the propagating gardens and White House greenhouses.

It is also necessary that these propagating gardens should be sewered and drained, and an appropriation of $2,500 is asked and recommended.

The greenhouse structures were maintained in good condition during the year. Woodwork was repaired where needed, broken glass replaced with new glass, two of the houses and the glass roofs of others painted. Furnaces and flues were cleaned and leaking pipes repaired. Apparatus for operating ventilating sashes was placed in two houses. Three new cold frames were built and sashes in old frames repaired. A boiler was placed in the stokehole of houses numbered 27 and 28 and connected for use in heating the office building.

The old wooden and glass superstructure of house No. 8 was torn down and a new superstructure erected in its place.

The old soil and potting shed was torn down and an addition to the new one built.

In the nursery the work required to maintain the improved part of the grounds in a neat and cleanly condition was extended, and necessary care was given to the growing stock. This stock, which was formerly growing in the front part of the grounds, was lifted and replanted in the rear south of the greenhouses, and the ground in front graded, sown down in grass seed, and some of the new roads projected for the improvement of the grounds constructed. The old water-lily tank in the front grounds was filled up and the ground graded and made into lawn surface. Forty-one evergreen trees were planted at the north entrance to the grounds in front of the office building and a group of evergreens planted on the lawn at that front. The ground in the rear of that building was graded and covered with top soil. A privet hedge was planted along the east side of the nursery grounds and 600 cubic yards of earth were used in filling low portions of the addition to the nursery grounds which was transferred to the jurisdiction of this office, by order of the Chief of Engineers, by Lieut. Col. Charles J. Allen, Corps of Engineers, U. S. Army, August 27, 1901.

This office is frequently in receipt of requests for the loan of plants from the gardens for the use of churches, fairs, festivals, etc., and demands are constantly made for flowering and decorative plants for private purposes.

All such requests have to be declined, as either the loan or gift of any plants would be in violation of the following extract from the Act of Congress approved June 20, 1878:

Provided, That hereafter only such trees, shrubs, and plants shall be propagated at the greenhouses and nursery as are suitable for planting in the public reservations to which purposes only the said productions of the greenhouses and nursery shall be applied.

In addition to the plants (over 1,000,000) propagated at these gardens for the reservations under the charge of this Office, there were also propagated over 30,000 plants for other Departments of the Government. After those were supplied, the surplus remaining, about 20,000 plants, were distributed to hospitals, Government offices, and to whoever asked for them.

Appended hereto is a list showing the stock grown, purchased, planted in the parks, and distributed during the year.

List of stock propagated, purchased, and distributed.

	Number.	Kind.	Number of varieties.
PROPAGATED.			
Plants for stock and park planting	966,447	40	90
Plants for greenhouses and nursery and fall planting	61,288	13	102
Plants for grounds of Treasury Department	17,575	15	20
Plants for grounds of State, War, and Navy Departments	2,981	7	11
Plants for Interior Department	800	(a)	(a)
Plants for Government Printing Office	500	(a)	(a)
Plants for Fish Commission	500	(a)	(a)
Plants for Bureau of Engraving and Printing	700	(a)	(a)
Plants for Marine Barracks	800	(a)	(a)
Plants for Washington Aqueduct	585	(a)	(a)
Plants for Army Hospital	600	(a)	(a)
Plants for Washington Barracks	3,540	(a)	(a)
Plants for Post-Office Supply Division	600	(a)	(a)
Plants for Fort Myer	700	(a)	(a)
Plants for Naval Hospital	700	(a)	(a)
Surplus stock distributed as follows:			
Bureau of Education	1,070	(a)	(a)
Mount Vernon	1,290	(a)	(a)
Spanish Treaty Claims Commission	700	(a)	(a)
Emergency Hospital	700	(a)	(a)
Homeopathic Hospital	700	(a)	(a)
Naval Observatory	500	(a)	(a)
General public	15,555	(a)	(a)
Total	1,078,831	....	....
PURCHASED.			
Hardy flowering bulbs	31,000	3	16
Tender flowering bulbs	25,300	4	4
Plants	1,088	11	30
Trees	214	13	20
Shrubs	495	14	30

[a] General stock.

NOTE: The item "Surplus stock," comprising about 2 per cent of the aggregate number of plants propagated, consisted mainly of the least thrifty plants which remained on the greenhouse benches after the best stock for park planting had been culled out, and constituted also a reserve stock to provide for possible replantings of the beds earliest planted, which in some seasons become necessary from late frosts.

The best of these surplus plants were sent out to hospitals, etc., that applied for them, and the remainder, which would necessarily be thrown out, as the Government had no further use for them, were distributed promiscuously to the general public.

	Number.
Grown in greenhouses for autumn, winter, and spring bloom:	
Bouvardias	500
Chrysanthemums	5,000
Carnations	6,428
Poinsettias	600
Roses	7,100
Smilax	2,500
Violets	2,000
Heliotropes	2,000
Potted and boxed for winter forcing:	
Roman hyacinths	15,000
Narcissus	5,000
Lilium harrisii	300
Lily of the valley	5,000
Planted at propagating gardens:	
Gladioluses	1,000
Tuberoses	1,500
Cosmos	1,000
Celosias	1,660
Pansies	1,200
Planted at propagating gardens—Cont'd.	
Shrubs	412
Trees	202
Tropical plants	2,000
Planted in the parks:	
Trees	12
Shrubs	83
Planted in parks for spring bloom:	
Bulbs	31,000
Pansies	28,800
Planted in parks in May and June for summer decoration:	
Bedding plants	958,947
Tropical plants	7,500
Vases stocked:	
Number	23
Plants	1,000
Fountains stocked:	
Number	8
Plants	43

ELECTRIC LIGHTS FOR PROPAGATING GARDENS.

Sundry civil appropriation act for the fiscal year ending June 30, 1903, approved June 28, 1902, contained a provision for the installation of six electric lights at the propagating gardens, as follows—

> For introducing, lighting, and maintaining six arc electric lights at the propagating gardens, at seventy-two dollars per light per annum, which sum shall cover the entire cost of lighting and maintaining in good order each of said arc electric lights, four hundred and thirty-two dollars—

and the contract made August 27, 1902, by this Office for electric lights for the public grounds for the fiscal year contained an item providing for the erection of those six lamps. Work was at once commenced by the electric-light company laying the conduits for the cables, and by September the conduits had been laid and the brick hand-holes on the sites for the poles constructed. Owing to delays at the foundry, however, the electric-light company did not receive the iron poles until February 13, 1903. Their erection and the installation of the cables was completed on February 24, and four of the lamps lighted from that date and the fifth lamp from February 27. Owing to an accidental break in the conduit, which necessitated the relaying of a portion of it, the connections for the sixth lamp could not be made until March 13, and it was lighted from that date.

SHOPS BUILDING, PROPAGATING GARDENS.

Sundry civil appropriation act for the fiscal year ending June 30, 1903, appropriated the sum of $2,000 for purchase and repair of machinery and tools for shops at nursery, and for grading around the building. Under this provision the following machinery was purchased and installed in the shops building during the month of April, 1903:

One saw bench with equipment, belted to one 3-horsepower electric motor.

One pipe-threading machine, belted to one 4-horsepower electric motor.

One cut gear, belted to one 1-horsepower electric motor.

One one-half horsepower electric motor, belted to a forge blower, the latter already in place.

The foregoing machinery is operated by electricity supplied from the dynamo in the power house of the Washington Monument. To convey this current to the shops, 1,562 feet of terra-cotta conduit was

laid in a trench with concrete bottom from the power house to the shops building, and 3,072 feet of No. 0 standard lead-covered cable run through the conduit.

The final connections with the motors were made, the current turned on, and the machinery started on May 4.

The ground and slopes of the roadway between the shops building and the storehouse building were rough graded and a retaining wall of cement concrete was built on either side of this roadway, and a retaining wall of same materials was also built at the south end of the shops building and at the north end of the storehouse.

STATUES.

Following is a list of the 22 statues in the public grounds of Washington under charge of this Office. This table gives the character of each statue, its location, the sculptor, the date of unveiling, and its cost, how provided for, etc. Supplementary to this list of completed statues is the list of the statues in contemplation and for which appropriations have been made. These tables were compiled by Mr. William Livingston Browning, of this Office, and represent much careful labor.

Photographs of these 22 statues follow the tables.

Statues in the public grounds, District of Columbia, under charge of office public buildings and grounds.

[Compiled by William Livingston Browning, March 1, 1903.]

Statue.	Description.	Location.	Sculptor.	Date unveiled.	Remarks.
Gen. Andrew Jackson	Equestrian	Center of Lafayette Park	Clark Mills	Jan. 8, 1853	Cost of statue, $32,000; act of Congress Mar. 3, 1853, appropriated $20,000 of the amount, and $12,000 was paid by the Jackson Democratic Association of Washington, D. C.; cost of pedestal, $8,000. Appropriated by Congress, acts of Aug. 31, 1852, and Mar. 3, 1853.
General Washington	....do	Washington Circle; Pennsylvania avenue, Twenty-third and K streets NW.	....do	Feb. 22, 1860	Cost of statue and pedestal, $50,000. Appropriated by Congress, act of Mar. 3, 1853.
Gen. John A. Rawlins	Standing	South of Pennsylvania avenue, between Eighth and Ninth streets NW. *a*	J. Bailey	Completed in Nov., 1874. (No formal ceremonies.)	Act of Congress June 10, 1872, appropriated $10,000 for statue, and act of June 22, 1874, appropriated $3,000 for a pedestal, which last act authorized its erection in Rawlins square.
Gen. Winfield Scott	Equestrian	Scott Circle; Massachusetts and Rhode Island avenues, Sixteenth and N streets NW.	Henry K. Brown	Turned over to the Government informally in 1874.	Appropriated by Congress: For statue, Mar. 2, 1867, $20,000; July 15, 1870, $15,000; for pedestal, July 10, 1872, $42,000.
President Lincoln	Standing on high column.	In front of United States court-house; at head of John Marshall place.	Miss Vinnie Ream	Unknown	Authorized by act of Congress July 25, 1866, with provision that the statue should not cost more than $10,000.
President Lincoln	Sitting	Lincoln Park; East Capitol and Eleventh and Thirteenth streets.	Thomas Ball	Apr. 14, 1876	Erected by the emancipated citizens of United States, who subscribed $18,000 for the statue. Its erection in public grounds authorized by act of Congress, June 23, 1874, which also appropriated $3,000 for a pedestal for the statue.
Maj. Gen. James B. McPherson.	Equestrian	McPherson square; Vermont avenue, Fifteenth and K streets NW.	Louis T. Rebisso, Cincinnati, Ohio.	Oct. 18, 1876	Cost of statue, $23,500—paid by the Society of the Army of the Tennessee. Cost of pedestal, $25,000. Appropriated by Congress, act of Mar. 3, 1875.
Gen. Nathaniel Green	....do	Stanton Park; Massachusetts and Maryland avenues, Fifth and C streets NE.	Henry K. Brown	Turned over to the Government informally in 1877.	Appropriated for by Congress: For statue, act June 24, 1874, $40,000; for pedestal, act Mar. 3, 1875, $10,000.
Maj. Gen. George H. Thomas.	....do	Thomas Circle; Massachusetts and Vermont avenues, Fourteenth and M streets NW.	J. Q. A. Ward	Nov. 19, 1879	Cost of statue, $35,000—paid by the Society of the Army of the Cumberland. Cost of pedestal, $25,000. Appropriation by Congress, act of July 31, 1876.
Admiral Farragut	Standing	Farragut square; Seventeenth and K streets NW.	Mrs. Vinnie (Ream) Hoxie.	Apr. 25, 1881	Cost of statue, $20,000. Appropriated by Congress, act of Apr. 16, 1872.
Prof. Joseph Henry	....do	Smithsonian Grounds	W. W. Story	Apr. 19, 1882	Cost of statue and pedestal, $15,000. Appropriated by Congress, June 1, 1880.
Admiral Du Pont	....do	Du Pont Circle; Massachusetts and Connecticut avenues, Nineteenth and P streets NW.	Launt Thompson	Dec. 20, 1884	Cost of statue and pedestal, $20,500. Appropriated by Congress, as follows: Act of Mar. 3, 1884, $10,500; act of Feb. 25, 1882, $10,000.

Appropriated by Congress: $7,500 for statue, act Mar. 11, 1882; $30,000 for pedestal, act July 7, 1884; subscribed by the Society of the Army of the Cumberland for statue, $25,039.
Cost of statue and pedestal, $50,000. Appropriated by Congress, act of Mar. 3, 1885.
For statue and pedestal, act of Mar. 2, 1889, $40,000; act of Mar. 3, 1891, $10,000.
Presented to the Government by the Photographic Association of America; unveiled in National Museum Aug. 15, 1890.
Presented by physicians and surgeons of the United States; act of Congress, Mar. 2, 1895, authorized its erection in public grounds and appropriated $1,500 for a pedestal.
Presented by Mr. Stilson Hutchins to United States. Act of Congress, July 1, 1898, authorized its erection in public grounds and appropriated $4,000 for a pedestal for same.
Cost of statue and pedestal, $65,000; $50,000 appropriated by Congress, acts of Mar. 2 and 3, 1889; $15,000 paid by Society of the Army of the Tennessee.
Erected by the American Institute of Homeopathy. Act of Congress, Jan. 31, 1901, authorized its erection in public grounds and appropriated $4,000 for a foundation.
Erected by the Masonic Fraternity of United States. Act of Congress, Apr. 9, 1898, authorized its erection in public grounds and states its cost shall not be less than $10,000.
Cost of statue and pedestal, $22,500, appropriated by Congress act of Mar. 3, 1901, $7,500; act of Feb. 14, 1902, $15,000.

hteenth and Nineteenth streets. By act of Congress, May
der permission granted by the officer in charge of public

Errata, annual report of the officer in charge of public buildings and grounds, Washington, D. C., for the fiscal year ending June 30, 1903.

[To be attached to page 2560 of the Annual Report of the Chief of Engineers, 1903.]

Item 5.—President Lincoln. Instead of information given, read:

Description.	Location.	Sculptor.	Date unveiled.	Remarks: How provided for, etc.
Standing, column.	In front of United States court-house in Judiciary Square.	Lot Flannery, of Washington, D. C.	About 1869..	Erected by popular subscription by citizens of the District of Columbia.

President Garfield .... do
General Lafayette and compatriots .... do
Gen. Winfield Scott Hancock. .... Equestrian
L. J. M. Daguerre .... Standing
Dr. Samuel D. Gross .... do
Daniel Webster .... do
Gen. John A. Logan .... Equestrian
Dr. Samuel Hahnemann .... Sitting
Gen. Albert Pike .... Standing
Rochambeau .... do

a The statue of General Rawlins was o
17, 1886, $500 was appropriated for its remo
b The statue of Daguerre was removed
buildings and grounds Apr. 12, 1897.

Statues in the pu ... *buildings and grounds.*

Statue.	Description.		Remarks.
Gen. Andrew Jackson...	Equestrian	C	Cost of statue, $32,000; act of Congress Mar. 3, 1853, appropriated $20,000 of the amount, and $12,000 was paid by the Jackson Democratic Association of Washington, D. C.; cost of pedestal, $8,000. Appropriated by Congress, acts of Aug. 31, 1852, and Mar. 3, 1853.
General Washington	.....do	V	Cost of statue and pedestal, $50,000. Appropriated by Congress, act of Mar. 3, 1853.
Gen. John A. Rawlins...	Standing	S	Act of Congress June 10, 1872, appropriated $10,000 for statue, and act of June 22, 1874, appropriated $3,000 for a pedestal, which last act authorized its erection in Rawlins square.
Gen. Winfield Scott	Equestrian	S	Appropriated by Congress: For statue, Mar. 2, 1867, $20,000; July 15, 1870, $15,000; for pedestal, July 10, 1872, $42,000.
President Lincoln.......	Standing on high column.	I	Authorized by act of Congress July 25, 1866, with provision that the statue should not cost more than $10,000.
President Lincoln.......	Sitting	L	Erected by the emancipated citizens of United States, who subscribed $18,000 for the statue. Its erection in public grounds authorized by act of Congress, June 23, 1874, which also appropriated $3,000 for a pedestal for the statue.
Maj. Gen. James B. McPherson.	Equestrian	M	Cost of statue, $23,500—paid by the Society of the Army of the Tennessee. Cost of pedestal, $25,000. Appropriated by Congress, act of Mar. 3, 1875.
Gen. Nathaniel Green...	.....do	S	Appropriated for by Congress: For statue, act June 24, 1874, $40,000; for pedestal, act Mar. 3, 1875, $10,000.
Maj. Gen. George H. Thomas.	.....do	T	Cost of statue, $35,000—paid by the Society of the Army of the Cumberland. Cost of pedestal, $25,000. Appropriation by Congress, act of July 31, 1876.
Admiral Farragut.......	Standing	F	Cost of statue, $20,000. Appropriated by Congress, act of Apr. 16, 1872.
Prof. Joseph Henry	.....do	S	Cost of statue and pedestal, $15,000. Appropriated by Congress, June 1, 1880.
Admiral Du Pont........	.....do	D	Cost of statue and pedestal, $20,500. Appropriated by Congress, as follows: Act of Mar. 3, 1884, $10,500; act of Feb. 25, 1882, $10,000.

President Garfield	do	First street and Maryland avenue NW.	J. Q. A. Ward	May 12, 1887	Appropriated by Congress: $7,500 for statue, act Mar. 11, 1882; $30,000 for pedestal, act July 7, 1884; subscribed by the Society of the Army of the Cumberland for statue, $25,039.
General Lafayette and compatriots.	do	Southeast corner Lafayette Park.	Alexander Falquiere and Antonin Mercie.	Completed in Apr., 1891. No ceremonies	Cost of statue and pedestal, $50,000. Appropriated by Congress, act of Mar. 3, 1885.
Gen. Winfield Scott Hancock.	Equestrian	Hancock place; Seventh street and Pennsylvania avenue NW.	Henry Ellicott	May 12, 1896	For statue and pedestal, act of Mar. 2, 1889, $40,000; act of Mar. 3, 1891, $10,000.
L. J. M. Daguerre	Standing	Smithsonian grounds	Jonathan Scott Hartley.	Set in position in Apr., 1897.[b]	Presented to the Government by the Photographic Association of America; unveiled in National Museum Aug. 15, 1890.
Dr. Samuel D. Gross	do	do	A. Sterling Calder	May 5, 1897	Presented by physicians and surgeons of the United States; act of Congress, Mar. 2, 1895, authorized its erection in public grounds and appropriated $1,500 for a pedestal.
Daniel Webster	do	West of Scott Circle, Massachusetts and Rhode Island avenues and N street NW, between Sixteenth and Seventeenth streets.	G. Trentanove	Jan. 18, 1900	Presented by Mr. Stilson Hutchins to United States. Act of Congress, July 1, 1898, authorized its erection in public grounds and appropriated $4,000 for a pedestal for same.
Gen. John A. Logan	Equestrian	Iowa Circle, Vermont and Rhode Island avenues and Thirteenth and P streets NW.	Franklin Simmons	Apr. 9, 1901	Cost of statue and pedestal, $65,000; $50,000 appropriated by Congress, acts of Mar. 2 and 3, 1889; $15,000 paid by Society of the Army of the Tennessee.
Dr. Samuel Hahnemann	Sitting	East of Scott Circle; Massachusetts and Rhode Island avenues and N street NW, between Fifteenth and Sixteenth streets.	Charles Henry Niehaus.	June 21, 1900	Erected by the American Institute of Homeopathy. Act of Congress, Jan. 31, 1901, authorized its erection in public grounds and appropriated $4,000 for a foundation.
Gen. Albert Pike	Standing	Indiana avenue, Third and D streets NW.	G Trentanove	Oct. 23, 1901	Erected by the Masonic Fraternity of United States. Act of Congress, Apr. 9, 1898, authorized its erection in public grounds and states its cost shall not be less than $10,000.
Rochambeau	do	Southwest corner Lafayette Park.	M. Hamar, of Paris	May 24, 1902	Cost of statue and pedestal, $22,500, appropriated by Congress act of Mar. 3, 1901, $7,500; act of Feb. 14, 1902, $15,000.

[a] The statue of General Rawlins was originally located in Rawlins square, on New York avenue, between Eighteenth and Nineteenth streets. By act of Congress, May 17, 1886, $500 was appropriated for its removal to the present location.

[b] The statue of Daguerre was removed from the National Museum and set up in the Smithsonian grounds under permission granted by the officer in charge of public buildings and grounds Apr. 12, 1897.

Statues in contemplation (supplemental list).

Statue.	Description.	Location.	Sculptor.	When to be completed.	Remarks.
Gen. William T. Sherman.	Equestrian	Just south of United States Treasury.	Carl Rohl-Smith	To be completed Sept. 1, 1903, and to be unveiled Oct. 15, 1903.	Appropriated by act July 5, 1892, $50,000; appropriated by act Mar. 2, 1895, $30,000. Subscribed by the Army of the Tennessee, for statue, $11,000.
Gen. Philip H. Sheridan.	do	Sheridan Circle; Massachusetts avenue and Twenty-third street, between P and Q streets NW.	J. Q. A. Ward		Act of Mar. 2, 1889, $40,000; act of Mar. 3, 1891, $10,000; for pedestal and statue.
Gen. Ulysses S. Grant	A memorial; a long terrace, with equestrian statue and auxiliary groups.	On the axis of the Capitol, to the west of First street NW.	Henry Merwin Shrady, sculptor; Edward P. Casey, architect.		Authorized by act of Feb. 23, 1901, which limits the cost to $250,000.
Gen. George B. McClellan.	Equestrian	Not decided			Authorized by act of Mar. 3, 1901, which limits the cost to $60,000.
Baron von Steuben	do	do			Act of Feb. 27, 1903, $50,000.
Count Pulaski	do	do			Act of Feb. 27, 1903, $50,000.

GEN. ANDREW JACKSON, CENTER OF LAFAYETTE PARK.

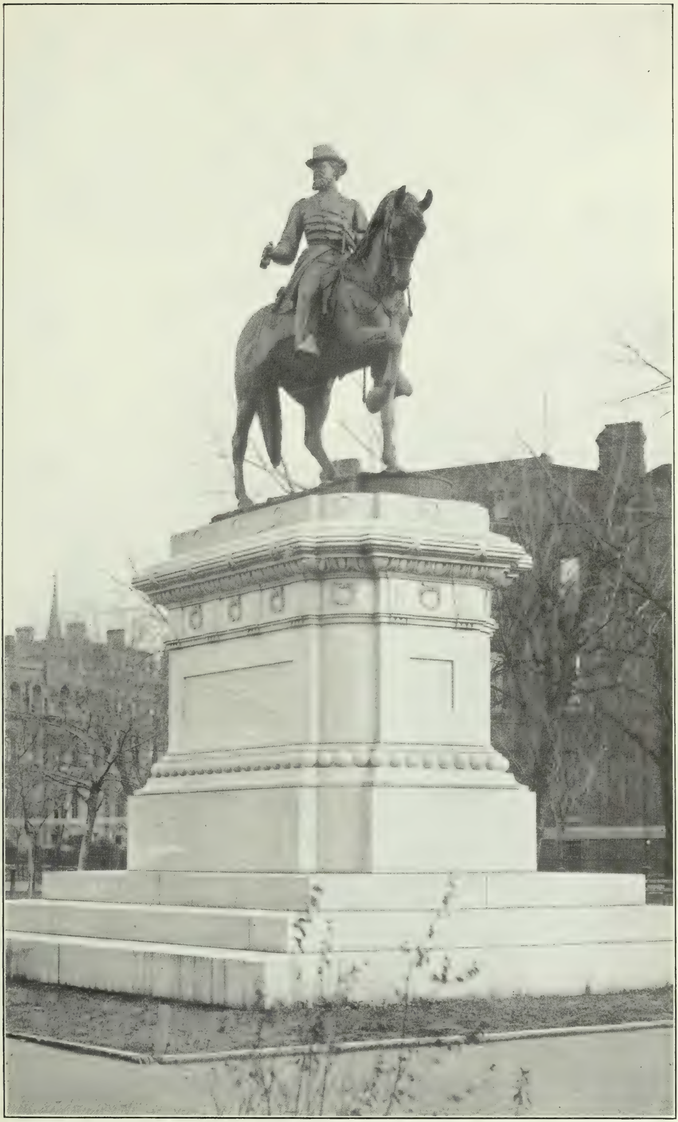
GENERAL WASHINGTON, WASHINGTON CIRCLE, PENNSYLVANIA AVENUE AND TWENTY-THIRD STREET.

GEN. JOHN A. RAWLINGS, PENNSYLVANIA AVENUE, BETWEEN EIGHTH AND NINTH STREETS NW.

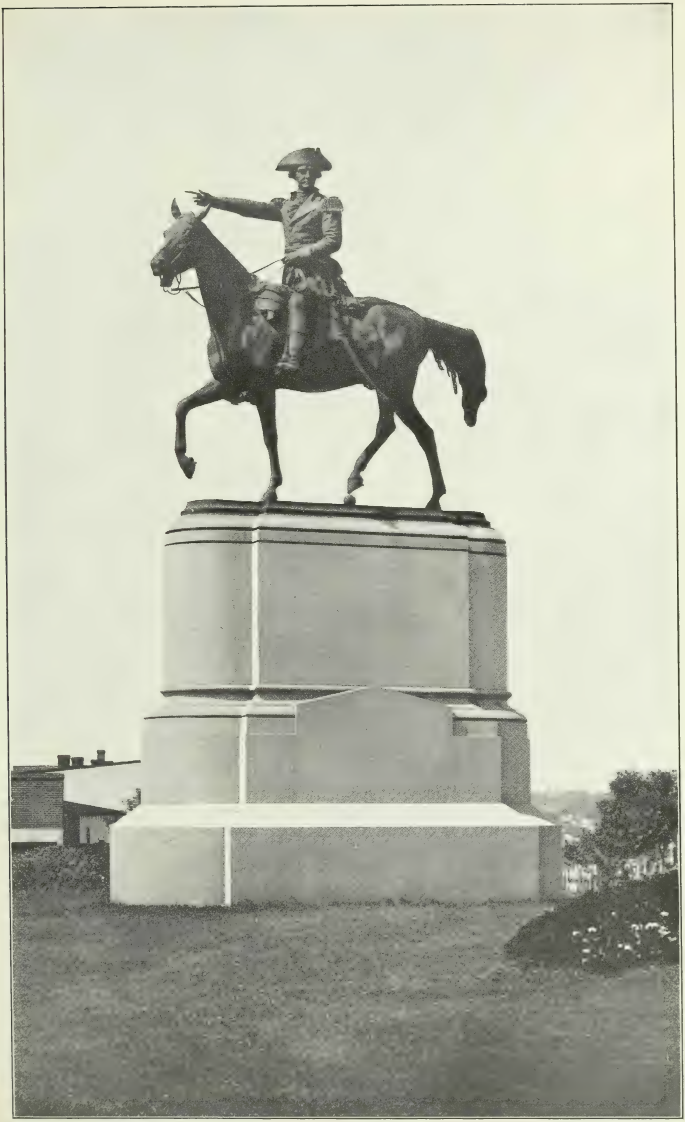
GEN. WINFIELD SCOTT, SCOTT CIRCLE, SIXTEENTH AND N STREET NW.

ABRAHAM LINCOLN, IN FRONT OF UNITED STATES COURT HOUSE.

ABRAHAM LINCOLN, LINCOLN PARK.



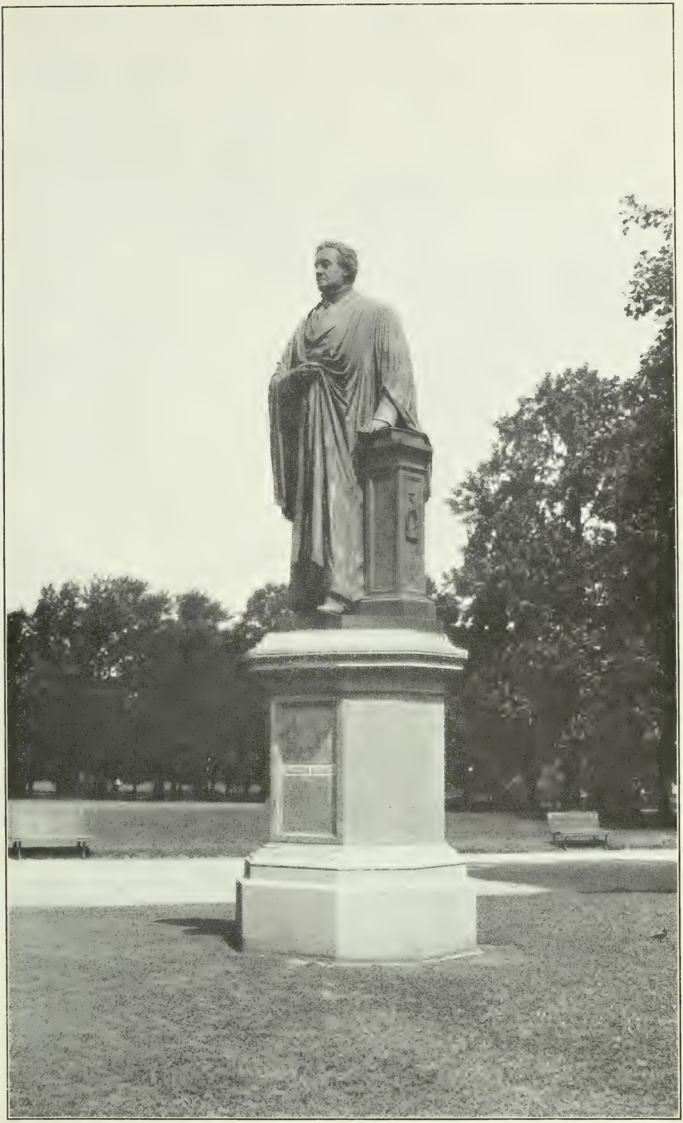
MAJ. GEN. JAMES B. McPHERSON, McPHERSON SQUARE, FIFTEENTH AND K STREETS NW.



GEN. NATHANAEL GREENE, STANTON PARK, FIFTH AND C STREETS NE.

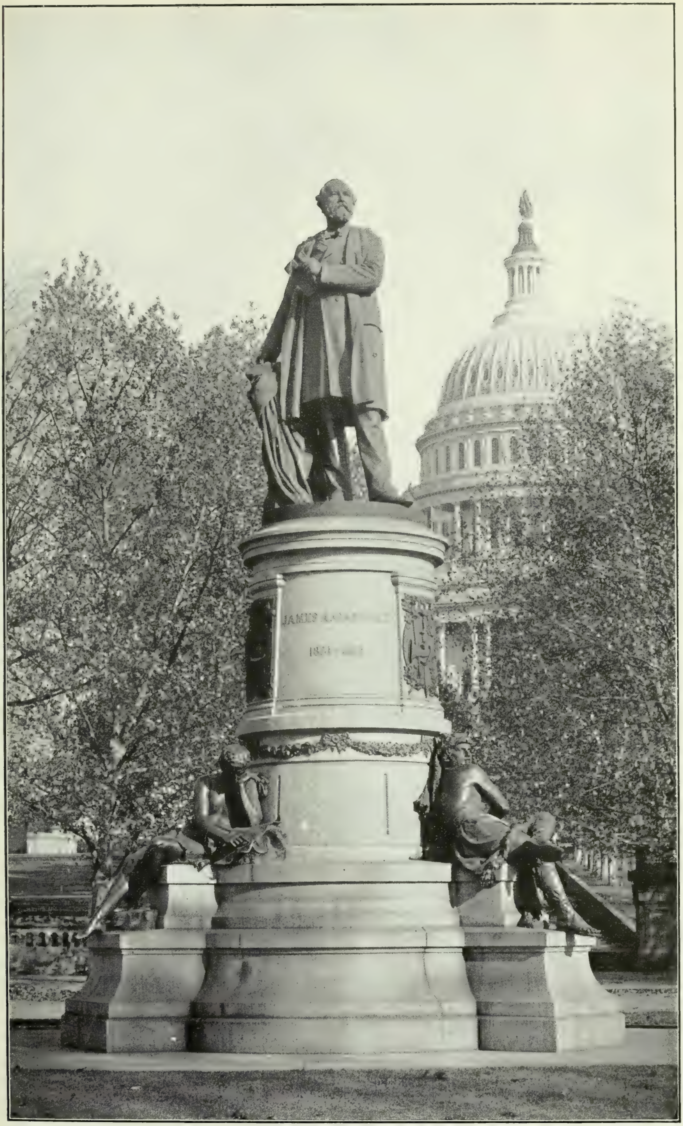
MAJ. GEN. GEORGE H. THOMAS, THOMAS CIRCLE, FOURTEENTH AND M STREETS NW.

ADMIRAL FARRAGUT, FARRAGUT SQUARE, SEVENTEENTH AND K STREETS NW.



PROF. JOSEPH HENRY, SMITHSONIAN GROUNDS.

ADMIRAL DU PONT, DUPONT CIRCLE, NINETEENTH AND P STREETS NW.



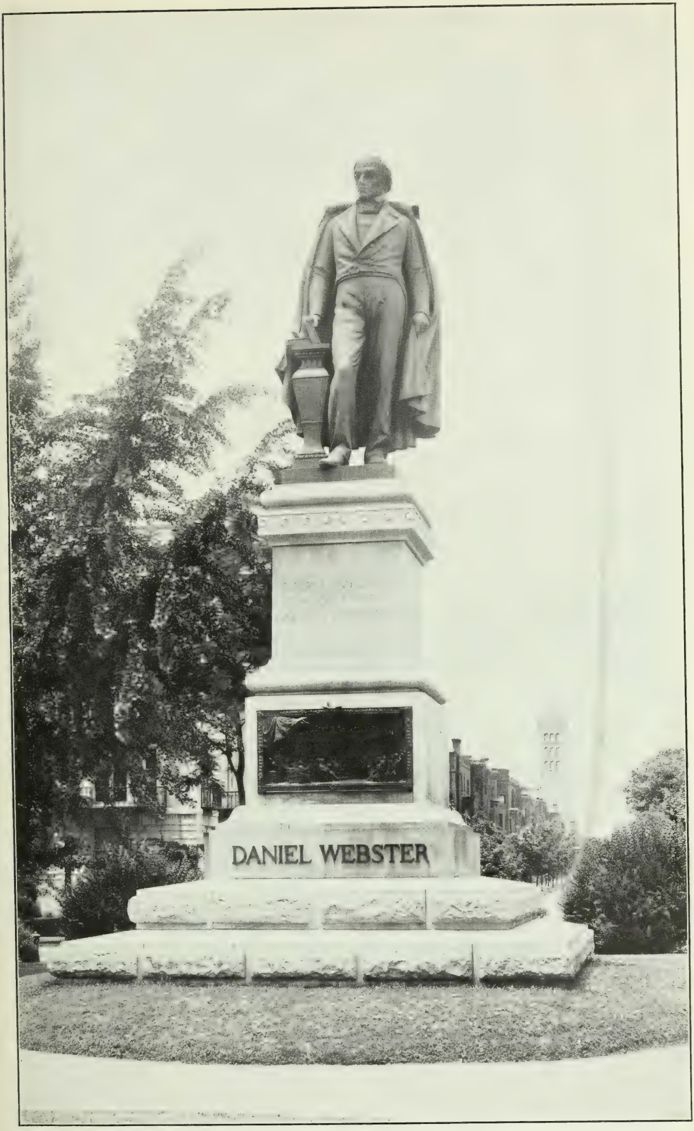
PRESIDENT GARFIELD, MARYLAND AVENUE AND FIRST STREET NW.

GENERAL LA FAYETTE AND COMPATRIOTS, SOUTHEAST CORNER OF LAFAYETTE PARK.

GEN. WINFIELD SCOTT HANCOCK, HANCOCK PLACE, PENNSYLVANIA AVENUE AND SEVENTH STREET NW.

L. J. M. DAGUERRE, SMITHSONIAN GROUNDS.

DR. SAMUEL D. GROSS, SMITHSONIAN GROUNDS.



DANIEL WEBSTER, RESERVATION AT MASSACHUSETTS AVENUE, BETWEEN SIXTEENTH AND SEVENTEENTH STREETS NW.

GEN. JOHN A. LOGAN, IOWA CIRCLE, THIRTEENTH AND P STREETS NW.

DR. SAMUEL HAHNEMANN, RESERVATION AT MASSACHUSETTS AVENUE, BETWEEN FIFTEENTH AND SIXTEENTH STREETS NW.

ALBERT PIKE, INDIANA AVENUE, THIRD AND D STREETS NW.

ROCHAMBEAU, SOUTHWEST CORNER OF LAFAYETTE PARK.

ACCEPTED MODEL FOR THE MEMORIAL OF GEN. ULYSSES S. GRANT.

STATUE OF GENERAL SHERMAN.

The sculptor and contractor for the Sherman statue, Mr. Carl Rohl-Smith, died August 20, 1900, while on a visit to his home in Denmark. By resolution of the statue commission, December 3, 1900, the widow was authorized to complete her husband's work, using therefor such expert assistance as might be found necessary. A new contract for this purpose was executed with Mrs. Rohl-Smith on April 8, 1901, which provided that the monument should be completed within two years. The work is making good progress, but it has been necessary to extend the time for completing the work until September 1, 1903, owing to unavoidable delay in getting the last plaster models finished.

The date of October 15, 1903, has been fixed for the unveiling of this statue, for the expenses of which Congress appropriated the sum of $4,000 under date of June 28, 1902.

By the same act the unexpended balance of the appropriation made June 6, 1900, for a stone coping around the statue was made available for the improvement of the grounds, and in addition thereto, the sum of $1,500 was provided for the same purpose and under the authority thus granted, a gravel roadway 676 feet long and 30 feet wide, and a walk 535 feet long and 10 feet wide have been constructed outside of the granite coping around the south and west sides of the site of the statue; 723 feet of granite curb were also set and 973 linear feet of stone gutters, 30 inches wide, constructed, 103 feet of terra cotta pipe laid, and 1 brick drain trap constructed for surface drainage.

Studies are being made to determine the best plan and method of laying out the grounds within the stone coping which surrounds the site of the statue to give it a harmonious setting.

In deficiency act approved December 22, 1902, the sum of $8,000 was appropriated for extra steps and mosaic work at the base of the statue. On February 21, 1903, a contract was entered into for furnishing and setting the extra steps, and under that contract two courses of granite steps have been set in place around, and a few feet out from, the lowest steps of the pedestal. Upon the space left between the new steps and the steps of the pedestal there will be laid a floor of marble mosaic, contracts for which were entered into February 28, 1903, and June 29, 1903. These contracts provide that the floor must be completed by August 15, 1903.

STATUE OF GENERAL GRANT.

By act approved February 23, 1901, Congress appropriated $10,000 for designs for a statue or memorial to Gen. U. S. Grant. Under date of April 10, 1901, the commission in charge issued an invitation to sculptors to submit competitive designs, and published the terms governing the competition.

In answer to this invitation 23 sculptors submitted 27 models during the month of March, 1902, which, by the courtesy of the trustees of the Corcoran Gallery of Art were placed on exhibition in the basement of that building in April. From the models thus submitted two models were selected by the statutory commission for further competition, and the artists of those two were requested to submit larger models of the equestrian group of their design.

The final result of the competition was the selection of the design submitted by Henry Merwin Shrady, sculptor, and Edward P. Casey,

architect. This statue or memorial consists of a long marble terrace with an equestrian figure of General Grant in the center and auxiliary groups at the ends representing field artillery, and cavalry. A photograph of the accepted design is herewith.

A site for this memorial has been selected on the axis of the Capitol to the west of First street west.

By act of June 28, 1902, Congress appropriated the sum of $50,000 to enable the commission to commence the erection of the memorial, and authorized the commission to enter into a contract or contracts for the completion of said memorial for a total sum not to exceed $240,000. Under the authority thus conveyed a contract covering the entire work for the erection of the memorial has been prepared and submitted for the signatures of the sculptor and architect. The contract provides that the memorial shall be completed within five years from the date the contract is signed.

STATUE OF GENERAL McCLELLAN.

By sundry civil act approved March 3, 1901, Congress appropriated $50,000 for the preparation of a site and the erection of a pedestal for and the completion of a statue of the late Maj. Gen. George B. McClellan.

Under date of May 3, 1901, the commission in charge issued an invitation to sculptors to submit competitive designs and published the terms governing the competition. In answer to this invitation 19 sculptors submitted 21 models during the month of April, 1902, which were exhibited in the basement of the Corcoran Gallery of Art in May. From the models submitted four were selected by the commission for further competition, and the artists of those four were requested to submit an enlarged model of their design.

This they did, but as none were satisfactory to the monument commission, or the advisory commission, all were rejected. The action of the monument commission, consisting of Hon. Elihu Root, Secretary of War; Hon. George Peabody Wetmore, United States Senate, and Gen. George D. Ruggles, is shown in the following resolution:

June 17, 1903.

Resolved, That inasmuch as it appears by the final letter of advice from the advisory committee, consisting of Messrs. Saint Gaudens, French, and McKim, that no model submitted upon the competition is satisfactory, the commission exercises the right reserved in the programme of competition and rejects all the designs and models submitted.

The commission will now attempt to get a satisfactory model and statue from a distinguished artist without competition.

STATUE OF GEN. PHILIP H. SHERIDAN.

This statue is being made by Mr. J. Q. A. Ward under a contract made several years ago.

At its meeting June 17, 1903, the monument commission having it in charge decided that the statue should be located in Sheridan circle at Massachusetts avenue and Twenty-third street, between Q and R streets NW.

STATUE OF ROCHAMBEAU.

As stated in the annual report of this office for the fiscal year 1902, this statue was completed and unveiled in May, 1902, and work commenced restoring the ground around the base of the pedestal. In

July, 1902, this latter work was completed by grading and sodding the ground, constructing gravel and asphalt walks and finishing out the park coping. The following inscription was cut in September, 1902, on the north side of the pedestal:

** By the Congress **
May XXIV, MDCCCCII.

MONUMENT TO GEN. HUGH MERCER.

By act approved June 28, 1902 (Statutes, Vol, 32, part 1, p. 491), Congress appropriated the sum of $25,000 for the erection of a monument at Fredericksburg, Va., to the memory of Gen. Hugh Mercer, to be expended under the direction of the Secretary of War, the city of Fredericksburg to furnish the site. By indorsement of July 26, 1902, the work of erecting the monument was assigned by the War Department to this office. On November 1, 1902, the officer in charge, Colonel Bingham, submitted a report of a visit made by him to Fredericksburg, and of an inspection of the several sites proposed for the monument. On February 10, 1903, the Secretary of War issued an order relative to the acquisition of a site, the submission of designs for the monument, and the approval of the same by him, the said order to be carried into execution by the officer in charge of public buildings and grounds. On April 8, 1903, the Secretary of War addressed a communication to Mr. Edward V. Valentine, a sculptor of Richmond, Va., inviting him, in accordance with a recommendation of the city council of Fredericksburg, to submit, on or before October 1, 1903, in this city, designs for a bronze statue of General Mercer, not equestrian, together with plans for a granite pedestal and accessories, and on April 10, 1903, Mr. Valentine accepted the terms of the invitation.

LINCOLN.

To one having charge of most of the existing monuments in Washington and having official connections with those which have been provided for but not yet built, it is constantly brought home that there is a striking omission in the lists. To Washington has been erected the grandest monument of the world, while to the man who stands only second to him in the love and esteem of the American people no suitable memorial at the nation's capital has been built or provided for. It is understood that the real reason for this apparent neglect is the difficulty of deciding upon the form and location that this memorial should take.

It is respectfully suggested that this matter receive early, vigorous, and continuous attention; that everybody be invited to contribute ideas on the subject, and that as soon as possible a design and location be decided upon for a national memorial to Abraham Lincoln.

SETTEES, TOOLS, MANURE, CONSTRUCTION AND REPAIR OF POST-AND-CHAIN FENCES, AND REMOVING SNOW AND ICE.

During the year 285 park settees were repaired and 316 painted. All settees in the parks were examined, and those found loose were refastened to the ground with stakes and wire.

Repairs were made to lawn mowers, wheelbarrows, and miscellaneous tools; edge tools sharpenened and kept in good order, and new tools purchased from time to time as required.

About 1,200 cubic yards of compost was made by mixing stable manure with good soil, and, together with about 143 cubic yards of clear manure, were spread upon park lawns.

The raising of the grade of B street NW. north of the compost grounds on B street between Eighteenth and Nineteenth streets by the District government resulted in the surface water from the streets being discharged into these grounds. To prevent flooding, the grade of the grounds has been raised fully 15 inches with earth and coal ashes received free of expense. The fence inclosing the grounds was repaired and a new gate put up.

Repairs were made to iron post-and-chain fences, posts out of line were straightened, and chain tightened. Iron post-and-chain fences were erected around eleven of the small triangular reservations hitherto uninclosed, requiring 278 posts and 2,181 feet of chain. Chain was also run through the posts which had been set in position around nine other reservations during the previous fiscal year, requiring over 2,500 feet of chain. At 5 reservations where the area was enlarged by the narrowing of the sidewalks by the District government, it was necessary to add to the length of the fences, and this was done by erecting 28 additional posts and placing 259 feet of chain.

The snow and ice were removed as soon as possible after storms from the walks around and through the various parks and park places. The snowfall of last winter was not heavy and the sum allotted for removing it was sufficient for the purpose.

PAINTING WATCHMEN'S LODGES, IRON FENCES, VASES, LAMPS, AND LAMP-POSTS.

Part of the iron fence around the White House grounds, three of the watchmen's lodges, the iron post-and-chain fences inclosing Du Pont Circle, Farragut Square, Stanton Park, and 69 of the small triangular reservations, consisting of 3,488 posts and 27,190 feet of chain and the iron post-and-bar fences around four other reservations, consisting of 208 posts and 1,664 feet of bars, the iron-railing fence around reservation No. 179, the iron railing around the statue of General Jackson in Lafayette Park, 170 lamp-posts, 144 lamps, and 7 plant vases were painted.

WATER PIPES AND FOUNTAINS.

Repairs have been made to water pipes and valves from time to time where necessary, new valves put on, and new iron extension boxes placed over valves to replace old boxes. In the autumn the water was shut off from the various parks, the hose valves removed, stored in the shops at the nursery, and repaired and repacked during the winter. In the spring the valves were replaced in the parks. During the year water pipe was introduced into 6 reservations hitherto unprovided with irrgiating facilities, and additional water pipe was laid in the Executive Mansion grounds, Lafayette Park, and the Smithsonian Grounds, requiring the laying of 222 feet of 1-inch lead pipe, 664 feet of 1¼-inch galvanized-iron pipe and 1,010 feet of 2-inch water pipe with necessary hose valves, and shut-off valves with iron boxes over them. There was also laid 167 feet of 1¼-inch water pipe for supplying fountains and 136 feet of terra-cotta pipe and 769 feet of 4-inch cast-iron pipe to drain them, and 32 feet of 4-inch cast-iron pipe and 688 feet of 6-inch

cast-iron pipe laid and 7 brick drain traps built for draining park walks. The total length of pipe laid for all purposes during the year was 3,658 feet.

The valve on the Capitol spring pipe line, located just south of the Potomac reservoir near the Howard University, was found to have been buried about 4 feet by the filling up of the ground. The brick manhole around the valve was therefore built up 6 feet higher, which brought it 2 feet above the present level of the ground. Repairs were made to two of the other valves on the line. At the request of this office an analysis of a sample of water from the Capitol spring was made in the office of the Surgeon-General of the Army and the result furnished the Superintendent of the Capitol.

There are 24 fountains with basins in charge of this office. Two additional ornamental iron fountains were erected during the year, and one of the old brick-and-cement fountain basins was replaced with a new ornamental iron fountain. Repairs were made to the cement basins of these fountains wherever needed, and they were cleaned out, stone copings repointed, stains removed from them, and the supply and waste pipes and valves maintained in order. The jets which, with a few exceptions, are of very simple character, were removed from the fountains in the autumn, the water turned off, jets requiring it repaired, and all replaced in the spring. Two of the large iron fountains were repainted.

There are 24 drinking fountains in the various parks and they have been maintained in good order and repairs made when necessary. At the approach of winter the water was shut off and the dippers removed. In the spring the dippers were replaced and the water turned on. Eighteen of the fountains were repainted.

LIGHTING THE PUBLIC GROUNDS.

The following parks are lighted with arc electric lights:

	Lights.
Executive Mansion grounds	8
President's Park	9
Monument Park	12
Franklin Park	9
Judiciary Park	9
Lincoln Park	8
Lafayette Park	6
Propagating gardens	6
Total	67

The number of gas lamps in the public grounds not connected with meters lighted nightly during the year was 234 from July, 1902, to January, 1903, and 233 from February to June, 1903.

In addition to the gas lamps mentioned in the foregoing paragraph, there are 71 burners in the Executive Mansion grounds connected with the meters in the Mansion.

All of the gas lamps in the public grounds have been maintained in good condition, minor repairs made, and old lanterns replaced with new boulevard lamps as the old ones became unserviceable.

It is earnestly hoped that the system of lighting the public grounds by electricity will be extended to the Smithsonian grounds and to the various improved parks throughout the city.

CONSTRUCTION AND REPAIR OF ASPHALT PAVEMENTS.

The following tabulated statement shows the area of asphalt roadway and foot-walk pavements constructed and repaired during the year:

Location.	New walks.			Repairs to roadways.	Repairs to walks.
	Length.	Breadth.	Area.		
	Feet.	*Feet.*	*Sq. yards.*	*Sq. yards.*	*Sq. yards.*
Reservation 144, New Hampshire avenue, Seventeenth and S streets, NW	....	....	....	....	10
Dupont Circle	....	....	....	....	108
Iowa Circle	....	....	....	....	400
Farragut Square	....	....	....	....	236
McPherson Square	....	....	....	....	400
Franklin Park	....	....	....	....	95
Reservation 68, Massachusetts avenue, Twelfth and L streets, NW	....	....	....	....	10
Lafayette Park	137	4	51	....	900
	333	5	352	....	....
	126	6			
	28	5½			
Reservation 32, Pennsylvania avenue, Fourteenth and E streets, NW	....	....	....	....	5
Reservation 33, Pennsylvania avenue, Thirteenth and E streets, NW	....	....	....	....	530
Reservation 36 (Hancock place), Pennsylvania avenue, Seventh and C streets, NW	....	....	....	....	18
Judiciary Park	216	5	120	....	360
Smithsonian grounds	....	....	....	780	246
Stanton Park	432	7	336	....	156
Lincoln Park	540	5	300	....	62
Folger Park	603	7	469	....	....
Marion Park	244	7	179	....	....
Total	2,659	....	1,807	780	3,536

In addition to the foregoing there were constructed 339 square yards of asphalt floor and 37 square yards of granolithic floor at the stable of the Executive Mansion.

DEPARTMENTAL TELEGRAPH LINE.

The telegraph lines now under control of this office are as follows:

The line of overhead wires consists of 82 poles, covering a distance of about 3½ miles, with a length of about 16 miles of wire. This line starts from the Lemon Building, where the main battery is located, and runs to the State, War and Navy Department building, thence to the Executive Mansion, thence to the Treasury Department, thence to G street, thence to Eighth street, thence to H street, thence to North Capitol street, and thence to the Capitol. Connected with it is one running from the Treasury Department along Fifteenth street to Ohio avenue, thence to Fourteenth and B streets NW. to the Agricultural Department, one down Fifth street to the Pension building, and one from the Treasury Department building, up Fifteenth street to I street, to Fifteen-and-a-half street, to K street, near Vermont avenue, connecting with the building temporarily occupied by the offices of the Department of Justice. There is also a short line running on the poles of the Western Union Telegraph Company from Fourteenth and G streets NW. down Fourteenth street to the building occupied by the Department of Commerce and Labor on the east side of Fourteenth street between Pennsylvania avenue and F street. This connection was made in May, 1903. There are about 500 feet of 13-conductor Patterson cable running from the cable pole in the Capitol grounds into the basement of the Senate and 250 feet of 20-conductor cable running from the cable pole on the corner of Seventeenth and G streets into the State, War and Navy building.

During the year the main and local batteries received necessary attention, and were maintained in good working order. All crosses and

other obstructions on the wires of the line were removed as soon as possible, instruments maintained in good condition, necessary repairs made to line wires, wires pulled taut, and slack cut out where required.

The telegraph office in the Treasury Department building was moved to another room and the necessary changes made in the running of the wires. A large 85-foot pole at the northwest corner of North Capitol and G streets was moved over to the southwest corner to get it away from the front of the new building for the Government Printing Office, the work being done without expense to this office other than the supervision of the regular electrician and lineman. A new 40-conductor cable was installed in the conduit running from the cable pole on the southwest corner of Seventeenth and G streets NW., and the State, War and Navy Department building also without expense to this Office. The pole at the southwest corner of North Capitol and H streets NW. was moved back a sufficient distance to permit the curb to be reset. Two wires were run from the switch board in the Post-Office Department building to the desk of the chief clerk in the office of the First Assistant Postmaster-General in an adjoining room. The office in the building of the Department of Agriculture was rewired with new wire.

All of the old telegraph cables which were temporarily made fast on the east and south walls of the Executive Mansion after the removal of the Executive offices therefrom were carefully removed and used in making the necessary connections through the new conduit into the new building for the offices of the President and all necessary connections made with the wires in that building as soon as the President's offices were moved thereto from their temporary quarters in the building at No. 22 Jackson Place.

Owing to the removal, on May 23, 1903, of the office of Public Buildings and Grounds from the State, War and Navy Department building to the Lemon Building, it was necessary to remove the main battery room to the latter building. Eight wires were strung from the pole at the southwest corner of Seventeenth and G streets NW. up to and over the roof of the Winder Building, and thence to a rear window on the fourth floor of the Lemon Building. All the necessary fixtures to carry those wires were made and placed in position on the roof of the Winder Building and the east wall of the Lemon Building, the main batteries moved over to the latter building and properly connected with the wires.

The necessity for replacing the poles and overhead wires with a system of underground cables has been urged in previous annual reports, and is so apparent that argument in its favor is unnecessary. Estimates have been prepared and submitted in previous years. The cost of the underground system will be about $30,000, and the matter is presented for such action as Congress may deem best.

OLD RECORDS OF THE CITY OF WASHINGTON.

The act of Congress approved March 3, 1899, provided:

SEC. 2. That the Secretary of War be, and he is hereby, authorized and directed to correct the records of the War Department in respect of any of the lots mentioned in Senate Document numbered two hundred and seventy-seven, Fifty-fifth Congress, second session (being a letter from the Secretary of War transmitting, in compliance with the resolution of the Senate of January twenty-seventh, eighteen hundred and ninety-eight, a letter from the Chief of Engineers, together with list of lots in the city of Washington, District of Columbia, the title to which the records of his office show to be in the United States, and list of lots in the city of Washington, District

of Columbia, which are shown by the records of his office to have been donated by the United States), upon the filing by an actual occupant of any of the lots mentioned in said document sufficient proof that the said occupant or the party under whom he claims has been in actual possession of the said lot or lots for an uninterrupted period of twenty years, so that said records shall show the title to said lots to be in the said occupant.

Between the date of that act and June 30, 1903, the required proof has been furnished by the occupant and the records corrected in the cases of twenty-three of the lots, so far as this office is informed, the title to which was shown to be in the United States. Of these ten were corrected in 1900, nine in 1901, two in 1902, and two in 1903.

EXTENSIONS OF BUILDINGS BEYOND THE BUILDING LINES IN THE CITY OF WASHINGTON.

The act of Congress approved March 3, 1891 (Vol. 26, Stat. L., p. 868), provides that no permits shall hereafter be granted for the extension of buildings beyond the building line except with the concurrent approval of the Secretary of War.

This office, by direction of the Secretary of War, is charged with investigation and report on these cases. During the fiscal year ending June 30, 1903, 486 applications for these permits have been referred from the War Department and reported on by this office.

RESERVATIONS WHICH ARE THE PROPERTY OF THE UNITED STATES OCCUPIED, IT IS BELIEVED, IN VIOLATION OF LAW.

[See map in Annual Report for 1894.]

The following reservations, claimed as the property of the United States, are now occupied, it is believed, without authority of law:

Reservation No. 125, by the Central Union Mission, as a place of worship.

Reservation No. 186, by the Bethany Chapel of the New York Avenue Presbyterian Congregation.

Reservation No. 249 is occupied as a lumber yard by a man who claims to rent it from a man in Port Deposit, Md.

Reservations Nos. 137, 138, 141, 152, 164, and 169 have been inclosed with iron or wire fences and partially improved by the owners of adjacent property.

The following also are improved and utilized by adjacent property owners: Nos. 61, 65, 67, 139, 141, 143, 161, 162, 167, 168, 175, 208, and 284.

In addition to the foregoing there is a valuable piece of United States ground, known as Reservation No. 94 A, lying between Rock Creek and Twenty-eighth street west, between I and K streets north, of which certain persons are now in unlawful occupation. This office has for several years been making efforts to secure possession of the property, which have so far proved unsuccessful, and on May 14, 1903, reported to the Chief of Engineers for the information of the War Department the result of its latest efforts in that direction. On May 20, 1903, the Secretary of War requested the Attorney-General to direct such course, on the part of the United States marshal, under the act of April 28, 1902, as would bring the question to judicial determination.

MONUMENT AND WHARF AT WAKEFIELD, VA., THE BIRTHPLACE OF WASHINGTON.

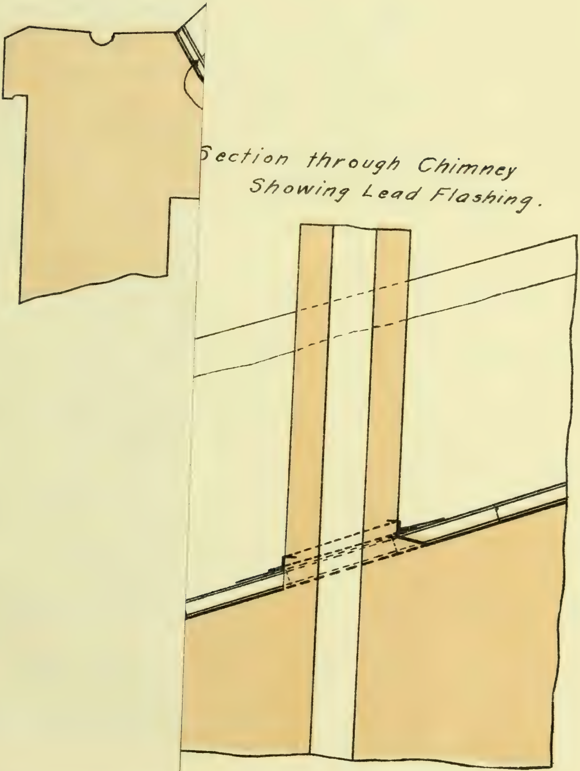
No work has been done during the year beyond the usual care extended by the United States watchman in charge.

As heretofore reported, the wharf was damaged by high tide and wind on Tuesday, October 18, 1898. There are no funds available for

PLATE 2.

Sectic

ethod of
proofing Roof
R.F. Battery
Harbor, Cal.
Scale ½" = 1'.

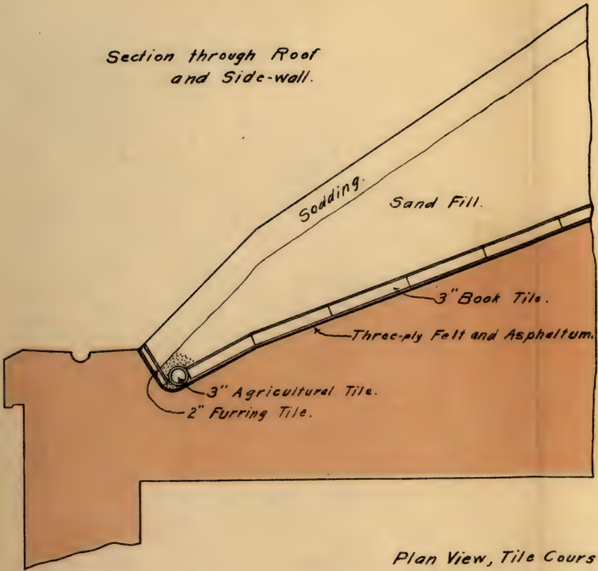


Section through Chimney
Showing Lead Flashing.

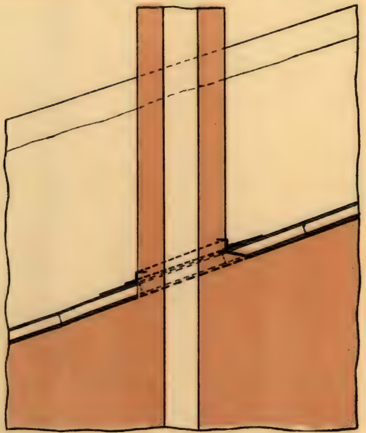
Method of Water-proofing Roof 6" R.F. Battery S.F. Harbor, Cal.

Scale ½" = 1'.

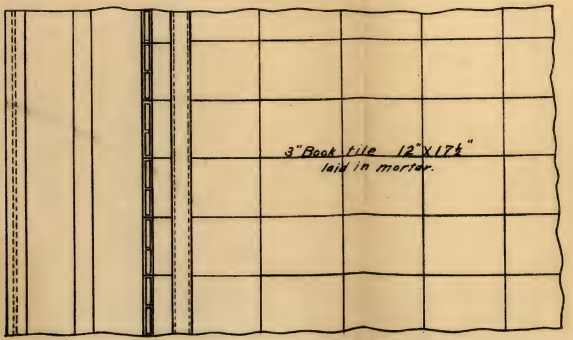
Section through Roof and Side-wall.



Section through Chimney Showing Lead Flashing.



Plan View, Tile Course.



repairing the wharf, and nothing can be done until an appropriation is provided for the purpose by Congress.

On February 25, 1903, the War Department issued a revocable license to a resident of Westmoreland County, Va., permitting him to make such temporary repairs, at his own expense, to the wharf as might be required to render it safe for use by him for loading lumber under the permit granted him on March 20, 1900, by the War Department.

UNITED STATES WHARF PROPERTY, WASHINGTON, D. C.

By act of Congress approved March 3, 1899, entitled "An act relative to the control of wharf property and certain public spaces in the District of Columbia," the following-described property is placed under the immediate jurisdiction and control of the Chief of Engineers of the United States Army:

The banks of the Potomac River from the north line of the Arsenal grounds to the southern curb line of N street south. * * *

By letter of March 11, 1899, from the office of the Chief of Engineers, I was directed, as representative of the Chief of Engineers, to assume control of the said wharf line, and since that date it has been in charge of this Office. No work has been done during the year, as there are no funds available for either the improvement or care of the property.

On February 26, 1903, the Chief of Engineers granted a revocable license to the general commanding the District of Columbia Militia to erect and maintain a wharf at the foot of O street for the use of the naval militia of the District of Columbia.

In the general deficiency act approved March 3, 1903, Congress made an appropriation to pay the owners for their wharf structures, warehouses, and other improvements on this property, and on March 12 this office addressed a letter to the special assistant United States attorney who had charge of the matter of ascertaining and reporting upon the amounts due the several claimants for their improvements, asking that he inform the Office whether the claimants had vacated the property in accordance with the decree of the supreme court of the District of Columbia making the awards, and that he also state the time when the Office could enter into possession of the property. After further correspondence on the subject the special attorney informed this Office, under date of May 25, that with one exception all persons heretofore in possession of the property had vacated it, and that the United States were at liberty to take possession of the entire property. The one exception noted was a Mr. Thomas R. Riley, who on May 26 applied for permission to remain in occupancy of the wharf and buildings used by him until they were actually needed by the Government. This application was submitted to the Chief of Engineers on May 28, with recommendation that Mr. Riley be permitted to occupy the property under a month-to-month lease upon the payment of a monthly rental of $50 in advance, and on June 16, 1903, a lease was executed between the Chief of Engineers and Mr. Riley under the terms mentioned.

Mr. Edward Whyte under date of June 8, 1903, applied for the lease of the wharf occupied by him for the past few years. This application has been approved by the Chief of Engineers and a form of lease was sent to Mr. Whyte on June 30, 1903, for signature.

A map of this water front accompanies this report.

REMOVAL OF OFFICE.

Under orders from the War Department dated May 7, 1903, the Office of Public Buildings and Grounds was moved on May 23 from the rooms on the basement floor of the west wing of the State, War, and Navy Department building, which it had occupied since February, 1888, to the fourth floor of the "Lemon Building."

SUMMARY OF WORK DONE DURING THE YEAR.

For convenience of reference a brief summary of the more important items of work accomplished during the year is given as follows:

Executive Mansion.—The mansion remodeled, redecorated, and refurnished, and an addition to it built. A portrait, with frame, of the late President McKinley, purchased and hung in the mansion. A separate building for the offices of the President erected. The conservatory and greenhouses attached to the mansion torn down and five of the greenhouses reerected at the propagating gardens. Repairs made to the stable. Extensive changes and improvements made in the grounds at the north front of the mansion.

Washington Monument.—Portions of the iron work painted and other painting done. A new door and storm door placed at the entrance. At the power house much miscellaneous painting done. A lubricator purchased and placed on the engine. In the lodge house carpentry, plumbing, and painting repairs made. A steam coil for heating the office and one for heating the waiting room made and placed in position. A new drinking fountain placed on the north side of the lodge for the accommodation of visitors.

Public grounds.—Three of the small unimproved reservations at the intersections of streets and avenues, containing 0.021 acre, brought to the first stage of improvement. The work of improving the grounds of Mount Vernon square around the new public library building commenced and partially completed. The 50-foot gravel roadway in the President's park, outside of the iron fence inclosing the south grounds of the Executive Mansion, covered with broken trap rock and trap-rock screenings, the area surfaced amounting to 7,960 square yards. The part of Potomac Park adjacent to the Washington Monument grounds extensively improved by grading, constructing a macadam roadway, bridle path and walk, new revetment wall, and increasing height of old revetment wall, constructing lawn surfaces, etc., and repairing old canal lock house at Seventeenth and B streets entrance for use as a lodge house. The superstructure of one of the greenhouses at the propagating gardens rebuilt, the nursery stock moved from the front to the rear of the grounds, and the front part of the grounds extensively improved. Six electric lights erected at the propagating gardens and machinery and electric motors for operating it installed in the shops building. A roadway 30 feet wide and a walk 10 feet wide constructed around the site of the statue of General Sherman. Two courses of extra granite steps constructed around the base of the pedestal of that statue, and a contract entered into for constructing a marble mosaic floor on the space between the new steps and the lowest step of the pedestal. The grounds around the statue of Rochambeau restored. About 1,200 cubic yards of compost made and, with about 143 cubic yards of clear manure, spread upon lawn surfaces. The grade of the compost grounds raised 15 inches. Iron post-and-chain fences erected

around 11 reservations, and chain run through the posts erected around 9 other reservations during the preceding year. Part of the iron fence around the Executive Mansion grounds, 3 of the watchmen's lodges, the iron post-and-chain fences inclosing 3 of the larger parks and 69 of the smaller reservations and the iron posts and bars inclosing 4 others, consisting of 3,696 posts, 27,190 feet of chain, and 1,664 feet of bars, the iron railing fence around 1 reservation, the iron railing around the statue of General Jackson in Lafayette Park, 170 lamp-posts, 144 lamps, and 7 plant vases painted. Two hundred and eighty-five park settees repaired and 316 painted. Two thousand and sixty-three feet of water pipe, 1,489 feet of iron drain pipe, and 4,169 feet of terra cotta drain pipe laid and 69 brick drain traps constructed. Seven hundred and twenty-three feet of granite curb set. Two new and additional ornamental iron fountains erected and 1 old brick and cement fountain basin replaced with a new ornamental iron fountain. One thousand eight hundred and seven square yards of additional asphalt foot walk laid and 780 square yards of asphalt roadway and 3,536 square yards of asphalt foot-walk pavement repaired and resurfaced. Four hundred and eighty-six applications for permits for the erection of projections beyond the building line investigated and reported upon. The office of Public Buildings and Grounds removed from the War Department building to the Lemon Building.

Estimates for the fiscal year ending June 30, 1905.

Salaries of employees, Public Buildings and Grounds, etc.:	
1 assistant engineer in Office Public Buildings and Grounds	$2,400
1 office clerk	1,800
1 office clerk	1,600
1 messenger	840
1 landscape gardener	2,000
1 surveyor and draftsman	1,500
Overseers, draftsmen, copyists, foremen, gardeners, mechanics, and laborers	35,000
1 first sergeant of park police in charge	1,000
1 second sergeant of park police	900
1 day policeman in Lafayette Park	840
1 night policeman in Lafayette Park	840
1 day policeman in Franklin Park	840
1 night policeman in Franklin Park	840
2 day policemen in Smithsonian grounds, at $840 each	1,680
2 night policemen in Smithsonian grounds, at $840 each	1,680
1 day policeman in Judiciary Park	840
1 night policeman in Judiciary Park	840
1 day policeman in Lincoln Park and adjacent reservations	840
1 night policeman in Lincoln Park and adjacent reservations	840
1 day policeman at Iowa Circle	840
1 night policeman at Iowa Circle	840
1 day policeman at Thomas Circle and neighboring reservations	840
1 night policeman at Thomas Circle and neighboring reservations	840
1 day policeman at Washington Circle and neighboring reservations	840
1 night policeman at Washington Circle and neighboring reservations	840
1 day policeman at Dupont Circle and neighboring reservations	840
1 night policeman at Dupont Circle and neighboring reservations	840
1 day policeman at McPherson and Farragut parks	840
1 night policeman at McPherson and Farragut parks	840
1 day policeman at Stanton Park and neighboring reservations	840
1 night policeman at Stanton Park and neighboring reservations	840
2 day policemen at Henry (Armory) and Seaton parks, at $840 each	1,680
2 night policemen at Henry (Armory) and Seaton parks, at $840 each	1,680

Salaries of employees, Public Buildings and Grounds, etc.—Continued.		
1 day policeman at Mount Vernon Park and adjacent reservations	$840	
1 night policeman at Mount Vernon Park and adjacent reservations	840	
2 day policemen at grounds south of Executive Mansion, at $840 each	1,680	
1 night policeman at grounds south of Executive Mansion	840	
1 day policeman for greenhouses and nursery	840	
1 night policeman for greenhouses and nursery	840	
1 day policeman at Monument Park	840	
1 night policeman at Monument Park	840	
1 day policeman at Monument Park annex (Potomac Park)	840	
1 night policeman at Monument Park annex (Potomac Park)	840	
1 day policeman at Garfield Park	840	
2 night policemen at Garfield Park, at $840 each	1,680	
1 watchman for the care of the Monument and dock at Wakefield, Va., the birthplace of Washington	300	
		$82,620
Contingent expenses, Public Buildings and Grounds:		
For contingent and incidental expenses, including purchase of professional and scientific books, periodicals, books of reference, blank books, photographs, and maps		700
Improvement and care of public grounds:		
Improvement and maintenance of grounds south of Executive Mansion	4,000	
Ordinary care of greenhouses and nursery	2,000	
Ordinary care of Lafayette Park	2,000	
Ordinary care of Franklin Park	1,000	
Improvement and ordinary care of Lincoln Park	2,000	
Care and improvement of Monument grounds and annex to Monument grounds (Potomac Park)	7,000	
Continuing improvement of Reservation No. 17 and site of old canal northwest of same	2,500	
Construction and repair of post-and-chain fences; repair of high iron fences; constructing stone coping about reservations; painting watchmen's lodges, iron fences, vases, lamps, and lamp-posts; manure and hauling the same; removing snow and ice; purchase and repair of seats and tools; trees, tree and plant stakes, labels, lime, whitewashing, and stock for nursery, flowerpots, twine, baskets, wire, splints, moss, and lycopodium, to be purchased by contract or otherwise, as the Secretary of War may determine; care, construction and repair of fountains; abating nuisances; cleaning statues, and repairing pedestals	16,050	
For improvement, care, and maintenance of various reservations	20,000	
For improvement, care, and maintenance of Smithsonian grounds	3,500	
For improvement, care, and maintenance of Judiciary Park	2,500	
For laying asphalt and other walks in various reservations	2,000	
For improvement, care, and maintenance of grounds of Executive Departments	4,000	
For such trees, shrubs, plants, fertilizers, and skilled labor for the grounds of the Library of Congress as may be requested by the Superintendent of the Library building	1,000	
For such trees, shrubs, plants, fertilizers, and skilled labor for the grounds of the Capitol as may be requested by the Superintendent of the Capitol building	3,000	
For improvement and maintenance of Executive Mansion grounds (within iron fence)	7,500	
For the employment of an engineer by the officer in charge of Public buildings and grounds	2,400	
For purchase and repair of machinery and tools for shops at nursery	2,000	
For broken stone, road covering for parks	2,000	
For curbing, coping, and flagging for park roads and walks	2,000	
For stone coping for Franklin Park	2,000	
For establishing, fitting up and maintaining children's playgrounds	10,000	

Improvement and care of public grounds—Continued.		
For commencing the work of relaying out the grounds of Garfield Park	$2,000	
For completing the improvement of the grounds of Mount Vernon Square around the new public library building	13,000	
For completing the improvement of the portion of Potomac Park between the tidal reservoir and the Washington Monument grounds and extending from Seventeenth street and Virginia avenue NW. to Maryland avenue and Fourteenth street SW	20,000	
For constructing a riverside drive in Potomac Park	160,000	
For a central heating plant for the propagating gardens	25,000	
For sewering and draining the propagating gardens	2,500	
		$322,950
Care, repairs, fuel, etc., Executive Mansion:		
For care, repair, and refurnishing Executive Mansion, to be expended by contract or otherwise as the President may determine	60,000	
Fuel for Executive Mansion, greenhouses, and stable	8,000	
For care and maintenance of conservatory and greenhouses	9,000	
For repairs to, and reerection of, greenhouses	3,000	
For building two new greenhouses	6,000	
For building a stable for the use of the President, the Executive Office and the Office of Public Buildings and Grounds, on a location in the President's park to be selected by the President	60,000	
		146,000
Lighting the Executive Mansion and public grounds:		
Gas, pay of lamplighters, gas fitters, and laborers; purchase, erection, and repair of lamps and lamp-posts; purchase of matches and repairs of all kinds; stoves, fuel, and lights for office and office stable, for watchmen's lodges, and for greenhouses at nursery: *Provided*, That for each 5-foot burner not connected with a meter in the lamps on the public grounds not more than $20 shall be paid per lamp for gas, including lighting, cleaning, and keeping the lamps in repair, under any expenditure provided for in this act, and said lamps shall burn every night on the average from forty-five minutes after sunset to forty-five minutes before sunrise, and authority is hereby given to substitute other illuminating material for the same or less price, and to use so much of the sum hereby appropriated as may be necessary for that purpose	20,000	
For lighting 6 electric arc lights in Executive Mansion grounds within the iron fence 365 nights, at not exceeding $80 per lamp per annum	480	
For lighting 6 electric arc lights at the propagating gardens 365 nights, at not exceeding $80 per lamp per annum	480	
		20,960
Lighting public grounds, District of Columbia:		
For lighting 7 arc electric lights in grounds south of Executive Mansion 365 nights, at not exceeding $80 per light per annum	560	
For lighting 32 electric arc lights in Lafayette, Franklin, Judiciary, and Lincoln parks 365 nights, at not exceeding $80 per light per annum	2,560	
For lighting 14 electric arc lights in grounds south of Executive Mansion and Monument Park 365 nights, at not exceeding $80 per light per annum	1,120	
		4,240
Repairs to water pipes and fire plugs:		
Repairing and extending water pipes, purchase of apparatus for cleaning them, purchase of hose, and for cleaning the springs and repairing and renewing the pipes of the same that supply the Capitol, the Executive Mansion, and the building for the State, War, and Navy Departments		2,500
Telegraph to connect the Capitol with the Departments and the Government Printing Office:		
For care and repair of existing lines		1,500
Total		498,150

Washington Monument, elevator, electric lights, and machinery connected therewith.

The following estimate for operating the elevator, the electric lights, and the machinery connected therewith for the fiscal year ending June 30, 1905, is submitted:

1 custodian, at $100 per month	$1,200
1 steam engineer, at $80 per month	960
1 assistant steam engineer, at $60 per month	720
1 fireman, at $50 per month	600
1 assistant fireman, at $45 per month	540
1 conductor of elevator car, at $75 per month	900
1 attendant on floor, at $60 per month	720
1 attendant on top floor, at $60 per month	720
3 night and day watchmen, at $60 per month	2,160
For fuel, lights, waste, oil, packing, tools, matches, paints, brushes, brooms, lanterns, rope, nails, screws, lead, electric lights, heating apparatus, oil stoves for elevator car and upper and lower floors, repairs to engines, boilers, dynamos, elevator, and repairs of all kinds connected with the Monument and machinery, and purchase of all necessary articles for keeping the Monument, machinery, elevator, and electric plant in good order	3,000
For constructing a reception room on the lower floor of the Monument	2,500
For paving the roadways around the Monument with asphalt	7,500
Total	21,520

As some of the preceding estimates are larger than amounts heretofore appropriated, and as some of them are new, the following explanations thereof are submitted:

1. I have asked for an increase of $600 per annum in the pay of the assistant engineer. The duties and responsibilities of this employee have been largely increased during the past two years. He has supervision over the large force employed about the parks. He lays out the work and sees that it is properly executed. He also exercises supervision over the work of improvements and repairs at the Executive Mansion and the building containing the offices of the President, and all these duties often require him to work outside of regular office hours. This work and the office work which he must necessarily perform in the preparation of plans, estimates, reports, etc., require abilities which are fully worth the compensation of $2,400 per annum asked, and it is earnestly recommended that the increase be granted.

2. I have asked for an increase of $50 per annum in the pay of the first sergeant of park police. The duties of this officer are as exacting and onerous as those performed by the sergeants of Metropolitan police, while the pay of the latter is $1,140 per annum.

3. I have asked for a second sergeant of park police at $900 per annum. The one sergeant now in charge of the force is overworked. During the day he has to ride on his bicycle over the whole city inspecting every park policeman, and also inspecting the outlying reservations not looked after by the park policemen. He has to come to this office every morning to make his report and receive instructions; he has to spend several hours a day at the police court several times a week, and in addition, he has to inspect the night policemen in the parks three times a week. There should be a second sergeant to assist him.

4. I have asked for an increase of $120 per annum in the pay of the park policemen. The Washington park policeman is probably the poorest paid man in the United States who has police duty to perform. He has practically the same duties as the Metropolitan police. The

same intelligence and physical qualifications are required of him. His moral character must be good. His discipline is much the same. He has as many arrests to make as the average policeman. He runs the same risks as to injury from vicious people as the man doing duty on the street. His duties are more exacting, as half of his duty hours are spent in cautioning people about violating the rules of the park and in looking after children. He has a uniform to buy once a year in order to look neat; yet the pay of these policemen is only $60 per month. The city government requires the street railway companies to pay their crossing police officers $75 per month for a great deal less exacting and laborious duty. The lowest grade on the Metropolitan police force receive $75 per month, and the officers who serve five or six years faithfully receive $90 per month. For these reasons the increase in pay asked is strongly recommended.

5. I have asked for 11 additional park policemen for night duty in parks where there are now no night men. Those 11 parks have now but 1 policeman each, who patrols them but eight hours out of the twenty-four. Those policemen have in addition from 5 to 20 outside reservations to look after, some of them nearly a mile distant. Their hours of duty are generally from 8 a. m. to noon and from 4 to 8 p. m. It is just as necessary to have those parks patrolled from noon to 4 p. m. and from 8 to 12 p. m. as at any other hours. During the off hours park loafers take advantage of the absence of the policemen to do about as they please and subject respectable people to annoyance. For these reasons it is urgently recommended that the increase in the force asked for be granted.

6. The appropriation of $1,000 for Lafayette Park is not enough to keep it in the condition in which it should be kept. This is the most highly improved and most centrally situated small park in the city, and is seen and used by more people than any other. It is respectfully urged that the appropriation for this park be the same as for Lincoln Park, namely, $2,000 per year.

7. I have asked for an increase of $1,000 in the appropriation for the Smithsonian Grounds. There are in these grounds 58 acres of land, and to keep this large park in proper condition there has been an appropriation of $2,500 yearly. That amount is not sufficient to do the work required of keeping lawns, trees, roads, walks, etc., in good condition, and it is respectfully recommended that it be increased to $3,500 per year.

8. An increase of $3,000 is asked for improvement, care, and maintenance of grounds of Executive Departments. The number of roses, flowering and foliaged bedding plants, etc., furnished the various Executive Departments and their bureaus during the last fiscal year, and which in several cases was a less number than they desired to procure from the propagating gardens, was in the aggregate over 30,000, having a commercial value of about $3,000. In addition, the gardens furnished the labor required for planting the grounds of the Interior Department, the Post-Office Supply Division, and the inclosed grounds at the Washington Aqueduct office, and other than those plantings no skilled labor could be provided for their care and maintenance, which would materially advantage their ornamental character during the summer and autumn months.

The amount requested for this service, $4,000, would, it is believed,

be an adequate sum to provide not only a more liberal supply of plants for the Executive Departments and their bureaus, but would also provide skilled labor where needed for the proper maintenance of the plantings.

9. An increase of $3,500 is asked for the inclosed grounds of the White House.

There are certain improvements which should be made in these grounds to make them conform to the new conditions. The new public entrance at the east, and the office entrance at the west, combined with the retained north entrance, render unnecessary the double roadways which reach the mansion from the south. This duplicate system of roadways is an inheritance from old conditions which no longer exist. Good taste and judgment require that the unnecessary roadways should be done away with, as they are not beautiful and are expensive to maintain, and grass, trees, shrubs, and gardens substituted for them. In many other ways these private grounds pertaining to the White House should be improved and beautified to make them conform to this splendid residence and to the development of private gardens and grounds throughout the country. The house of the President should have a proper and fitting setting amidst grounds and gardens of unexceptionable beauty. The amount appropriated for the grounds inside the iron fence, $4,000, is not enough to enable all the improvements desired to be made, and it is respectfully urged that in the next bill it may be increased to $7,500.

10. *Stone coping for Franklin Park.*—It being the wish of Congress that the public parks should be as open as possible, all the former high iron fences have been removed except where absolutely needed. This has left the edges of the parks with an unfinished appearance, which, in many cases, is very unsightly.

It has been found by experience that a single stone curbing gives a pleasing finish, and is sufficient to preserve a neat border line between park and sidewalk. Lafayette Square is an illustration.

Franklin Park, one of the prettiest and most frequented in Washington, suffers for lack of this. A simple but tasteful stone curb can be laid around it for $2,000, and the appropriation of that amount is respectfully urged.

11. The sum of $2,000 is asked to begin the work of relaying out the grounds of Garfield Park. The change in the grades of streets in the vicinity, due to the railroad construction of the Pennsylvania Railroad Company, and the change in the shape and dimensions of Garfield Park, due to the same cause, will require an entirely new laying out of the park. By using the park as a spoil bank all the filling may be accomplished without cost, and by taking advantage of circumstances great economy will result. It is therefore recommended that an appropriation of $2,000 be made for beginning work required in Garfield Park incident to the operations of the Pennsylvania Railroad.

12. I have asked for the sum of $10,000 for establishing and maintaining and caring for children's playgrounds on public reservations. By existing legislation the officer in charge of public buildings and grounds is authorized to grant the use of the public grounds for children's playgrounds, but it is respectfully submitted that permission to use the grounds for that purpose is not sufficient. An appropriation should be made for fitting them up, and every year the necessary appro-

priation should be made for their care, extension, and renewals as apparatus is worn out and broken. I do not believe that there is any other way in which a small amount of money can be expended which would do more good or give greater pleasure or result in more lasting benefit than money appropriated and expended for fitting up, caring for, and maintaining children's playgrounds.

13. An appropriation of $13,000 is requested for completing the improvement of the grounds of Mount Vernon Square, around the new public library building. The estimate submitted by this office in October, 1901, for the work amounted to $25,000, while the appropriation made by Congress for the fiscal year 1903 was but $10,000, which was sufficient to provide for only a portion of the work. A careful estimate of the cost of the work which should be done to complete the improvement gives the sum of $13,000, which, if appropriated, will make the total cost of the improvement $2,000 less than the original estimate. It is earnestly recommended that the sum requested be granted.

14. In October, 1901, this office submitted an estimate amounting to $100,000 for improving that portion of Potomac Park lying between the tidal reservoir and the Washington Monument grounds. By act of June 28, 1902, Congress appropriated the sum of $70,000 for the work. To complete the improvement more work is required than can be accomplished with the money provided. Much grading of the ground remains to be done, additional drainage provided, foot walks and bridle paths constructed, about 800 trees planted, and the Fifteenth street park roadway in the Monument grounds east of the propagating gardens improved so that it may be connected with the new waterside drive now under construction in Potomac Park. To accomplish the work outlined above will require the sum of $20,000, and the appropriation of that amount is respectfully urged.

15. An estimate of $160,000 is submitted for the construction of a riverside drive in Potomac Park. The Potomac River has never been accessible in a pleasant way to the people of the city, and this proposed drive is intended to make it so. It will be readily reached from the foot of Seventeenth street or Twenty-sixth street, and will furnish a new, beautiful, and unique feature to the city drives. The appropriation of the amount requested is earnestly recommended.

16. The sum of $25,000 is asked for constructing a central heating plant for the propagating gardens. The necessity for this must be apparent when it is considered that there are at the gardens 30 greenhouses which are heated by 20 separate and distinct heating plants, consisting each of furnaces and boilers, and each requiring to be attended to, fed, and cared for separately. The care of these separate plants requires much more labor than a single central plant doing the same work would, and the consumption of fuel is very considerably greater. In all private nurseries and collections of greenhouses similar to these propagating gardens a central heating plant is used because of its greater economy and efficiency. For the reasons given, the appropriation of the sum requested is earnestly recommended.

It is also necessary that these gardens should be sewered and drained, and an estimate of $2,500 for the purpose is submitted and recommended.

17. I have asked for $9,000 for the care and maintenance of the conservatory and greenhouses of the Executive Mansion, which is the

amount asked for the fiscal year ending June 30, 1904, but for which Congress granted but $7,000. The last-named amount is not sufficient to provide the force of gardeners, firemen, and laborers necessary for the proper care of the White House greenhouses, which have been reerected at the propagating gardens, and for the purchase of supplies, tools, plants, and seeds, and it is recommended that the increase of $2,000 be granted.

18. The few greenhouses of those formerly connected with the White House which it was possible to reerect at the propagating gardens are not of sufficient capacity to do the work required of them, but in their reerection the best was done with the funds available. They should be increased by the erection of at least two additional houses, and an estimate of $6,000 for the purpose is submitted and recommended.

One of these houses is required to give winter shelter to the extensive bay trees which during the summer adorn the terraces and porticoes of the White House.

19. An estimate of $60 000 is submitted and recommended for building a stable for the use of the President, the Executive Office, and the Office of Public Buildings and Grounds. The stables at present in use are inadequate and in nowise corresponding to or commensurate with the splendid residence of the President or his stable needs or the variety and importance of the business of the Executive Office and the Office of Public Buildings and Grounds, which are all accommodated together. The present stable is a low brick structure, built many years ago, and so near the ground as to be damp and unhealthy for horses. In connection with it is an old wooden stable, which is needed to increase the capacity to the required amount. They are situated on the President's Park, directly south of the State Department, on a plot of ground which will undoubtedly in the near future be selected as the site of a monument to one of the nation's great men. A proper and adequate stable should be built on a new site farther to the south on Seventeenth street, to be selected by the President.

20. I have asked for $2,500 for providing a comfortable waiting room on the lower floor of the Washington Monument. In inclement weather visitors have to wait inside the structure until the time comes for them to make the ascent. The place where they must wait is ordinarily very damp, cold, and uncomfortable, the walls being rough stone, upon which moisture condenses very freely. People sitting and waiting in this place are also exposed to the down draft of the chilled cave-like air of the interior of the Monument. The conditions are particularly favorable to the contracting of severe colds and pneumonia. For the protection of the thousands of people who visit the Monument a waiting room should be provided, and it is recommended that the sum asked be granted.

21. The road surrounding the Monument is a gravel road. The hill on which the Monument stands is a very windy spot, and during dry and windy weather the air around the Monument is filled with flying sand and gravel, which is painful and annoying to all within. This annoyance can be remedied by paving the roadway with asphalt, and an appropriation of $7,500 for the purpose is recommended.

Financial statement for fiscal year ending June 30, 1903.

Title of appropriation.	Available at beginning of fiscal year.	Appropriated since.	Expended during fiscal year.	Pledged by contract.	Unexpended balance to revert to Treasury.
Improvement and care of public grounds, District of Columbia, 1903	$147,050.00	....	$122,147.70	$24,844.04	$58.26
Improvement and care of public grounds, 1903	6,400.00	[a] $1,000.00	7,399.86	....	.14
Repairs, fuel, etc., Executive Mansion, 1903	40,000.00	[a] 13,000.00	49,907.19	....	3,092.81
Portrait of William McKinley (including frame)	2,500.00	....	2,500.00	....	....
Building for offices of the President, 1903	65,196.00	....	65,196.00	....	....
Extraordinary repairs and refurnishing of the Executive Mansion, 1903	475,445.00	....	470,931.14	4,513.86	....
Rent of temporary offices for the President, 1903	2,000.00	....	2,000.00	....	....
Lighting, etc., Executive Mansion, etc., 1903	13,364.00	[a] 4,000.00	14,661.78	2,802.22	....
Lighting public grounds, District of Columbia, 1903	3,816.00	....	3,789.14	....	26.86
Repairs to water pipes, 1903	2,500.00	....	2,499.24	....	.76
Telegraph to connect the Capitol with the Departments and the Government Printing Office, 1903	1,500.00	....	1,493.84	....	6.16
Contingent expenses, public buildings and grounds, 1903	700.00	....	700.00	....	....
Salaries of employees, public buildings and grounds, 1903	66,620.00	....	66,558.00	....	62.00
Care and maintenance of the Washington Monument, 1903	11,020.00	....	10,981.09	....	38.91
Equestrian statue of Gen. William T. Sherman	48,875.15	[b] 8,000.00	4,018.32	43,075.00	....
Purchase and repair of building where Abraham Lincoln died	100.00	....	7.50	....	....
Electric plant, Washington Monument	1,604.43	....	....	....	....
Designs for memorial or statue of Gen. Ulysses S. Grant	2,132.41	....	1,507.20	....	....
Pedestal for statue of Rochambeau	106.83	....	18.00	....	88.83
Monument to Gen. Hugh Mercer, Fredericksburg, Va	25,000.00	....	23.75	....	....
Pedestal for statue of Gen. George B. McClellan	50,000.00	....	....	....	....
Pedestal for statue of Gen. Philip H. Sheridan	50,000.00	....	....	50,000.00	....
Memorial to Ulysses S. Grant	50,000.00	....	....	....	....
Statue of Brig. Gen. Count Casimir Pulaski	....	[c] 50,000.00	....	....	....
Statue of Frederick William Augustus Henry Ferdinand (Baron) von Steuben	....	[c] 50,000.00	....	....	....

[a] Deficiency appropriation act approved March 3, 1903.
[b] Act approved December 22, 1902.
[c] Act approved February 27, 1903.

In conclusion, I desire to express my sincere appreciation and that of my predecessor of the faithful services rendered during the past year by the entire force in the employment of this office, and particularly to express sincere appreciation of the efficient and voluminous work done by Mr. E. F. Concklin, chief clerk; Mr. F. F. Gillen, assistant engineer, and Mr. George H. Brown, landscape gardener.

Special attention is called to "Notes on Codiæums," herewith as Appendix C, by the landscape gardener, and to the special varieties shown in the frontispiece.

I am, General, very respectfully, your obedient servant,

THOMAS W. SYMONS,
Colonel, U. S. Army,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

APPENDIX A.

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
THIRD FLOOR.					
ATTIC.					
Awnings	5	Apr. 10, 1903		$22.00	A. E. Kennedy
Bed, iron	1	Nov. 5, 1902		8.50	W. B. Moses & Sons.
Mattress, hair	1	do		9.50	do
Pillows, feather	2	do		4.80	do
Racks, towel, oak	3	Nov. 25, 1902	$1.50	4.50	do
Commodes, oak					
Rack, hat, walnut					
Bed, rosewood, double					
Bed, maple, double					
Fire screen, glass, in mahogany frame					
Corner seats					
Bookcase, revolving					
Bookcase, mahogany					
Umbrella stands, walnut					
Chairs, side, mahogany					
Tables, mahogany, marble top					
Tables, mahogany, invalids					
Umbrella cans, tin, painted green					
Table, maple, marble top					
Screen, fire, brass					
Table, walnut, breakfast					
Awnings, window, canvas					
Awnings for receptions					
Awnings for large bow window					
Fenders for radiators in vestibule					
Box, wooden					
Flags, post					
Flags, storm					
Boxes, pine, with locks to store curtains					
Crash, linen, used on floor at receptions ... lot					
Crash, linen, for East Room floor ... piece					
Pedestals covered with red plush					
Thermometers, round					
Thermometers					
Fire extinguisher, Babcock's					
Chairs, camp, wooden					
Tables, round, oak					
Lanterns, tin					
Axes					
Buckets, water					
Hose, canvas ... section					
Table, wicker, round					
Chairs, wicker, arm					
Chairs, wicker, rocking					
Settees, wicker					
Shades, window					
Curtains, tapestry (17 yards)					
Mirrors					
Stoves, gas, 4-tube					
Stoves, gas, 6-tube					
Rug, Smyrna					
Washstands					

Appendix A.

Executive Mansion June 30, 1903.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
21	Apr. 18, 1903	....	5	5				June 30, 1903	5
51	Dec. 24, 1902	3	1	4				do	4
51	do	11	1	12	4	Used in making over mattresses.	By authority of the President.	do	8
51	do	9	2	11					11
51	do		3	3				June 30, 1903	3
		2		2	1	Sold at auction	By order of the President.	do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1	1	do	do	do	0
		12		12				do	12
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		21		21				do	21
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		9		9				do	9
		1		1				do	1
		1		1				do	1
		2		2	2	Sold at auction	By order of the President.	do	0
		3		3	3	Accidentally broken.		do	0
		4		4	4	do		do	0
		1		1				do	1
		50		50				do	50
		8		8				do	8
		2		2	2	Accidentally broken.		do	0
		2		2				do	2
		6		6	2	Lost in making repairs.		do	4
		1		1				do	1
		1		1				do	1
		6		6	1	Sold at auction	By order of the President.	do	5
		4		4				do	4
		4		4				do	4
		10		10				do	10
		4		4				do	4
		3		3	1	Sold at auction	By order of the President.	do	2
		2		2				do	2
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		7		7	4	Sold at auction	By order of the President.	do	3

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
THIRD FLOOR—continued.					
ATTIC—continued.					
Chairs					
Chairs, rocking					
Tubs, foot					
Toilet sets					
Clock					
Matting, white, china ... yards					
Spring, woven wire					
Bed, cot, wooden					
Washstand, maple, marble top					
Chest, cedar					
Table, small, ebonized					
Rack, towel, ash					
Chair, wicker					
Cushion, chair					
Carpet ... yards					
Shade, window, drab					
Bed, folding, walnut					
Bureau, walnut					
Couch, walnut, upholstered					
Desk, writing, walnut					
Bookcase, walnut					
Chiffonier, oak					
Figures, bronze, female					
Foot bath, tin					
Basket, wicker, waste paper					
Stove, "Belle," No. 13					
Stand, walnut					
Chair, rocking, cherry, cane seat					
Table, walnut					
Scarf, table, plush, dark green					
Bowl, wash, china, thick					
Pitcher, china, thick					
Matting, white China ... yards					
Shade, white Holland					
Shade, green Holland					
Beds, single, iron					
Springs, single					
Mattresses, hair					
Pillows, feather					
Wardrobe, walnut					
Bureau, rosewood, marble top					
Chiffonier, walnut					
Stand, wash, cherry, marble top					
Table, walnut, marble top, small					
Table, lacquered					
Chair, arm, rosewood, upholstered					
Chairs, side, rosewood, upholstered					
Chair, side, cherry, cane seat					
Chair, side, ebonized, upholstered					
Bookcase, pine					
Clock, black marble					
Basket, waste, wooden					
Toilet set (5 pieces), odd					
Foot rest, mahogany, upholstered in leather					
Pitcher, china, for ice water					
Tray, silver plated					
Cushion, for window seat					
Pillows, sofa, covered with satin damask					
Mirrors, large, gilt frames					
Chairs, mahogany seats, upholstered in leather					

Executice Mansion June 30, 1903—Continued.

Voucher. No.	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
		6		6				June 30, 1903	6
		4		4				do	4
		2		2	1	Sold at auction	By order of the President.	do	1
		4		4				do	4
		1		1				do	1
		883⅔		883⅔				do	883⅔
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		128		128				do	128
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		2		2				do	2
		2		2	1	Sold at auction	By order of the President.	do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		41⅓		41⅓				do	41⅓
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		2		2				do	2
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		4		4				do	4
		2		2	2	Sold at auction	By order of the President.	do	0
		12		12	2	do	do	do	10

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
SECOND FLOOR.					
Northwest dressing room.					
Shades, window, green, Holland	3	Nov. 20, 1902	$3.84	$11.52	A. E. Kennedy
Carpet, Wilton ... yards					
Matting, white, china					
Shades, white, Holland					
Seat, window, upholstered in blue					
Lambrequin, mantel, blue					
Commode, mahogany					
Chair, rocking, mahogany, with cushion					
Chair, side, mahogany					
Desk, mahogany					
Bureau, mahogany					
Chiffonier, mahogany					
Table, invalid's, mahogany					
Chair, arm, upholstered in blue					
Fireboard, brass					
Laces, Brussels ... pair					
Cuspidor, china					
Mirror, mahogany, small					
Chair, side, walnut					
Foot tub, tin					
Footstool, wicker, painted white					
Northwest bathroom.					
Seat, bath					
Carpet, Wilton, velvet ... yards					
Northwest bedroom.					
Shades, window, green Holland	2	Nov. 20, 1902	3.84	7.68	A. E. Kennedy
Desk, mahogany	1	Apr. 23, 1903		94.00	do
Carpet, Wilton, blue ... yards					
Matting, white China ... do					
Matting, straw ... do					
Shades, window, white Holland					
Bedsteads, brass					
Springs, woven wire					
Mattresses, hair, 2 pieces each					
Loose covers for same					
Couch, upholstered in blue					
Chairs, arm, upholstered in blue					
Chair, corner, upholstered in blue					
Seat, window					
Cushions for rockers					
Hassocks					
Mirror, gilt frame					
Lambrequin, mantle, blue satin damask					
Screen, three fold, blue satin damask					
Wardrobe, walnut					
Wardrobes, mahogany					
Chairs, rocking, painted white					
Chair, rocking, mahogany					
Table, mahogany					
Stands, mahogany					
Table, painted					
Chiffonier, mahogany					
Dresser, rosewood					
Chairs, side, mahogany					
Fender, brass					
Fender, wire, spark					
Fire tools, brass, complete ... set					
Andirons, brass					
Fireboard, brass					
Clock, black marble					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
27	Nov. 27, 1902	3	3	6				June 30, 1903	6
		124		124	50	Used to make rug		do	74
		50		50	50	Worn-out and worthless.		do	0
		3		3	3	do		do	0
		1		1				do	1
		1		1	1	Worn-out and worthless.		do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				June 30, 1903	1
		$4\frac{1}{2}$		$4\frac{1}{2}$				do	$4\frac{1}{2}$
27	Nov. 27, 1902	2	2	4				June 30, 1903	4
13	May 2, 1903		1	1				do	1
		$229\frac{1}{3}$		$229\frac{1}{3}$	$229\frac{1}{3}$	Made into rug		do	0
		$108\frac{1}{3}$		$108\frac{1}{3}$	$108\frac{1}{3}$	Worn-out and worthless.		do	0
		57		57				do	57
		2		2	2	Worn-out and worthless.		do	0
		2		2				do	2
		2		2				do	2
		4		4				do	4
		8		8	8	Worn-out and worthless.		do	0
		1		1				do	1
		2		2	2	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		3		3				do	3
		2		2				do	2
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1	1	Worn-out and worthless.		do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
SECOND FLOOR—continued.					
Northwest bedroom—continued.					
Curtains, heavy, blue satin damask ... pairs..	....	....	....	....	....
Laces	....	....	....	....	....
Basket, wooden, waste paper	....	....	....	....	....
Pillows, sofa, blue satin damask	....	....	....	....	....
Bookcase, mahogany	....	....	....	....	....
Cuspidor, china	....	....	....	....	....
Quilt, bed	....	....	....	....	....
Curtains, sash ... pair..	....	....	....	....	....
Awnings, window	....	....	....	....	....
Screen	....	....	....	....	....
Chair, arm, upholstered in blue	....	....	....	....	....
Screen, 3-fold, mahogany	....	....	....	....	....
Rug, carpet, Wilton, solid green ... yards..	....	....	....	....	....
Bedroom, west of alcove hall, north side.					
Carpet, blue, Brussels ... yards..	....	....	....	....	....
Matting, white, China ... do....	....	....	....	....	....
Shade, white, Holland	....	....	....	....	....
Shade, green	....	....	....	....	....
Laces, Renaissance ... pair..	....	....	....	....	....
Curtains, heavy, blue satin damask ... do....	....	....	....	....	....
Bedsteads, iron and brass	....	....	....	....	....
Springs for above	....	....	....	....	....
Mattresses, hair	....	....	....	....	....
Pillows, feather	....	....	....	....	....
Bureau, mahogany	....	....	....	....	....
Bureau, rosewood	....	....	....	....	....
Washstand, mahogany	....	....	....	....	....
Wardrobe, rosewood	....	....	....	....	....
Table, rosewood, marble top	....	....	....	....	....
Chiffonier, walnut	....	....	....	....	....
Desk, walnut	....	....	....	....	....
Table, lacquered	....	....	....	....	....
Couch, upholstered in blue damask	....	....	....	....	....
Chair, Turkish, upholstered in blue damask..	....	....	....	....	....
Chair, arm, upholstered in blue damask	....	....	....	....	....
Chairs, side, upholstered in blue damask	....	....	....	....	....
Seat, window, upholstered in blue damask	....	....	....	....	....
Pillows, sofa, upholstered in blue damask	....	....	....	....	....
Quilt, silk	....	....	....	....	....
Basket, wooden, waste-paper	....	....	....	....	....
Candlesticks, china	....	....	....	....	....
Vases, glass, engraved	....	....	....	....	....
Vases, china, decorated in blue	....	....	....	....	....
Vase, flower, dark green	....	....	....	....	....
Toilet set, Japanese, 6 pieces	....	....	....	....	....
Pitcher, water, china	....	....	....	....	....
Mug, china, small	....	....	....	....	....
Clock, brass and glass	....	....	....	....	....
Match safe, Wedgewood, blue	....	....	....	....	....
Mirror, gold frame	....	....	....	....	....
Mirror, covered plush frame	....	....	....	....	....
Andirons, brass ... pair..	....	....	....	....	....
Fender, brass	....	....	....	....	....
Fire tools, complete ... set..	....	....	....	....	....
Vase, flower, glass	....	....	....	....	....
Ottoman	....	....	....	....	....
Chair, rocking, cherry	....	....	....	....	....
Hassock	....	....	....	....	....
Lamp	....	....	....	....	....
Shade, silk	....	....	....	....	....
Slip covers	....	....	....	....	....
Quilts, bed	....	....	....	....	....
Screen	....	....	....	....	....
Screen, Japanese	....	....	....	....	....
Towel rack	....	....	....	....	....
Hamper, clothes	....	....	....	....	....
Wardrobe, rosewood, plate-glass door (mirror)	....	....	....	....	....
Shade, window, green	1	Nov. 15, 1902	....	$3.84	A. E. Kennedy .

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		2		2				June 30, 1903	2
		2		2				do	2
		1		1				do	1
		4		4				do	4
		1		1				do	1
		1		1	1	Damaged in making repairs.		do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		$96\frac{2}{3}$		$96\frac{2}{3}$				do	$96\frac{2}{3}$
		$77\frac{1}{3}$		$77\frac{1}{3}$				June 30, 1903	$77\frac{1}{3}$
		$77\frac{1}{3}$		$77\frac{1}{3}$	$77\frac{1}{3}$	Worn-out and worthless.		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		1		1				do	1
		2		2				do	2
		2		2				do	2
		2		2				do	2
		2		2				do	2
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		8		8	8	Worn-out and worthless.		do	0
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
27	Nov. 27, 1902		1	1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
SECOND FLOOR—continued.					
Bedroom, east of alcove hall, north side.					
Shade, window, green	1	Nov. 20, 1902		$3.81	A. E. Kennedy
Table	1	Mar. 31, 1903		30.00	Old Colony Co
Carpet, Brussels ... yards					
Matting, white China ... do					
Shade, white, Holland, window					
Laces, Brussels ... pair					
Beds, brass, 3 feet 6 inches wide					
Springs					
Mattresses, hair					
Pillows, feather					
Quilts, silk					
Dresser					
Bureau					
Washstand					
Wardrobe					
Chiffonier					
Table, dressing, marble top					
Chair, Turkish, upholstered					
Chair, side, upholstered					
Couch					
Foot rest, mahogany, covered in leather					
Clock, black marble					
Vases, bronze					
Vases, bronze, small					
Fire tools, complete, brass ... set					
Basket, iron, grate					
Mirror, frame covered with plush					
Bottles, cut-glass					
Basket, wooden, waste					
Seat, window, upholstered, pink satin damask					
Pillow, sofa, covered with satin damask					
Statuettes					
Toilet set, china, 8 pieces					
Candle stand, brass					
Towel racks					
Picture, Christ in the Temple					
Picture, Madonna					
Picture, Madonna at organ					
Chair, rocking, maple, with cushion					
Slip covers					
Rug, carpet, Wilton, red, white figure ... yards					
Wardrobe, mahogany	1	Apr. 20, 1903		53.00	A. E. Kennedy
Large northeast bedroom.					
Curtains, window, muslin ... pair	2	Nov. 25, 1902	$2.75	5.50	A. E. Kennedy
Covers, table, plush	2	do	5.52	11.04	do
Splasher, washstand	1	do		.65	do
Shades, window, green	3	Jan. 2, 1903	3.84	11.52	do
Small northeast bedroom.					
Curtains, window, muslin ... pair	2	Nov. 25, 1902	2.75	5.50	A. E. Kennedy
Shades, window, green	2	Jan. 2, 1903	3.84	7.68	do
Small southeast bedroom.					
Curtains, window, muslin ... pair	2	Nov. 25, 1902	2.75	5.50	A. E. Kennedy
Shades, window, green	2	Jan. 2, 1903	3.84	7.68	do
Comfort, down	1	Jan. 30, 1903		9.00	do
Large southeast bedroom.					
Curtains, window, muslin ... pair	2	Nov. 25, 1902	2.75	5.50	A. E. Kennedy
Covers, table, plush	2	do	5.52	11.04	do
Splasher, washstand	1	do		.65	do
Shades, window	3	Jan. 2, 1903	3.84	11.52	do
Comfort, down	1	Jan. 30, 1903		9.00	do
Couch, upholstered in blue					

Executive Mansion June 30, 1903—Continued.

Voucher. No.	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
27	Nov. 27, 1902	1	1	2				June 30, 1903	2
31	Apr. 25, 1903		1	1				do	1
		74$\frac{2}{3}$		74$\frac{2}{3}$				do	74$\frac{2}{3}$
		74$\frac{2}{3}$		74$\frac{2}{3}$	74$\frac{2}{3}$	Worn-out and worthless.		do	0
		1		1	1	do		do	0
		1		1				do	1
		2		2				do	2
		2		2				do	2
		4		4				do	4
		4		4				do	4
		3		3				do	3
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1	1	do	do	do	0
		1		1	1	do	do	do	0
		1		1	1	do	do	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2	1	Sold at auction	By order of the President.	do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		10		10				do	10
		115		115				do	115
60	Apr. 25, 1903		1	1				do	1
9	Dec. 13, 1902		2	2				June 30, 1903	2
9	do		2	2				do	2
9	do		1	1				do	1
21	Jan. 10, 1903		3	3				do	3
9	Dec. 13, 1902		2	2				June 30, 1903	2
9	do		2	2				do	2
9	Dec. 13, 1902		2	2				June 30, 1903	2
9	do		2	2				do	2
9	Feb. 7, 1903		1	1				do	1
9	Dec. 13, 1902		2	2				June 30, 1903	2
9	do		2	2				do	2
9	do		1	1				do	1
21	Jan. 10, 1903		3	3				do	3
9	Feb. 7, 1903		1	1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
SECOND FLOOR—continued.					
Library, south side.					
Silk, China ..... yards..	19½	Nov. 13, 1902	$0.75	$14.63	A. E. Kennedy..
Cover, desk	1	Nov. 15, 1902		6.00	do
Mat, lamp	1	do		3.75	do
Shades, window, green	3	Nov. 20, 1902	3.84	11.52	do
Shades, window, white					
Curtains, heavy, satin damask ..... pair..					
Laces, Renaissance ..... do..					
Bookcases, walnut, large					
Bookcases, walnut, small					
Bookcases, revolving					
Table, rosewood, inlaid and carved					
Table, mahogany, marble top					
Sofas, upholstered, satin damask					
Lounge, upholstered, satin damask					
Chairs, Turkish, upholstered, satin damask					
Chairs, side, upholstered, satin damask					
Chair, arm, straight back					
Chair, arm, rosewood, upholstered					
Chair, arm, overstuffed, upholstered					
Easel, walnut					
Medallion in frame					
Piano, upright, Bradbury					
Bronze bust, George Washington					
Vases, bronze					
Figures, bronze, women					
Clock, black marble, with bronze top					
Statue, bronze, equestrian, General Jackson					
Candelabra, brass, 3 lights					
Vase, china, decorated in blue and gold					
Stool, piano, revolving					
Lambrequin, mantel					
Fender, brass					
Fire tools, brass, complete ..... set..					
Andirons, brass ..... pair..					
Cuspidors, brass					
Piano cover, green plush					
Mat, table, green plush					
Painting, oil, John Hamden					
Water color, statue, Daniel Webster					
Mirror, gilt frame					
Lamp					
Shade, lamp, umbrella					
Water color, marine scene					
Water color, marine scene					
Matting, straw ..... yards..					
Pillows, plush					
Pole, curtain, brass, with rings and brackets					
Table, tea, mahogany					
Screen					
Lamp					
Globe, lamp					
Tables, side, high, marble top					
Chairs, side, mahogany, solid wood backs					
Red bedroom (nursery).					
Shades, window, green	2	Nov. 20, 1902	3.84	7.68	A. E. Kennedy..
Carpet, brussells ..... yards..					
Laces, Renaissance ..... pair..					
Curtains, heavy, red satin damask ..... do..					
Shades, white, Holland					
Bedstead, youth's, single					
Chairs, arm, upholstered in satin					
Chairs, arm, upholstered in satin damask					
Couch, upholstered in satin damask					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
27	Nov. 22, 1902	....	19½	19½	....			June 30, 1903	19½
27	....do....	....	1	1	....			....do....	1
27	....do....	....	1	1	....			....do....	1
27	....do....	5	3	8	3	Worn-out and worthless.		....do....	5
		3	....	3	3	....do....		....do....	0
		3	....	3	....			....do....	3
		3	....	3	....			....do....	3
		3	....	3	3	Sold at auction....	By order of the President.	....do....	0
		4	....	4	1	....do....	....do....	....do....	3
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	1	Sold at auction....	By order of the President.	....do....	0
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1
		2	....	2	....			....do....	2
		6	....	6	....			....do....	6
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	1	Sold at auction....	By order of the President.	....do....	0
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		2	....	2	....			....do....	2
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	1	Worn-out and worthless.		....do....	0
		1	....	1	1	Sold at auction....	By order of the President.	....do....	0
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		59	....	59	....			....do....	59
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1
		1	....	1	....			....do....	1
		2	....	2	....			....do....	2
		2	....	2	....			....do....	2
27	Nov. 22, 1902	2	2	4	....			June 30, 1903	4
		103⅔	....	103⅔	103⅔	Made into rugs. (See below.)		....do....	0
		3	....	3	....			....do....	3
		3	....	3	....			....do....	3
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1
		3	....	3	....			....do....	3
		2	....	2	....			....do....	2
		1	....	1	....			....do....	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
SECOND FLOOR—continued.					
Red bedroom (nursery)—Continued.					
Chair, rocking, cherry, with cushion					
Table, carved					
Screen, 3-fold, cherry stained					
Desk, mahogany					
Bureau, rosewood					
Dresser, rosewood					
Wardrobe, walnut					
Washstand, walnut					
Towel rack, walnut					
Andirons, brass ... pair					
Fire tools, brass, complete ... set					
Fender, brass					
Basket, wooden, waste-paper					
Candlesticks, brass and glass ... pair					
Statuettes, fisherman and fisherwoman ... do					
Bottles, cut glass					
Clock, brass and glass					
Vases, flower, Japanese					
Vases, white and gold, scenes from the desert					
Vases, red and gold					
Match safe, brass					
Cabinet, wall, ebony					
Stand, ebony					
Toilet set, 7 pieces					
Lamp, electric					
Shade, lamp, red, umbrella					
Slip covers					
Chair, rocking, mahogany, high back					
Chairs, rocking, mahogany, low					
Cuspidor, china					
Cushion					
Mattress, hair					
Rugs, fiber					
Seats, window					
Rugs, Brussels, made from carpet (see above)					
Southwest bedroom.					
Mattress, hair	1	Nov. 15, 1902		$48.25	A. E. Kennedy
Bolster	1	do		5.80	do
Rug, green, Wilton, carpet					
Matting, white china ... yards					
Shades, white Holland					
Shades, green Holland					
Curtains, heavy, light green, satin damask, pair					
Laces, Renaissance ... pair					
Beds, brass, three-quarter					
Mattresses, hair					
Pillows, feather					
Springs					
Glass, pier, mahogany					
Washstand, walnut, marble top, high back					
Wardrobe, mahogany					
Dresser, walnut, marble top					
Dresser, mahogany, marble top					
Lounge, upholstered					
Chairs, arm, upholstered					
Chair, arm, upholstered, high back					
Chairs, side, upholstered					
Seats, window, upholstered					
Pillows, sofa					
Table, walnut, marble top					
Table, round, mahogany					
Toilet set, 7 pieces					
Fender, brass					
Andirons, brass					
Fire set, brass, complete					
Basket, brass, waste					

Executive Mansion June 30, 1903—Continued.

Voucher. No.	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
		1		1				June 30, 1903	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		10		10				do	10
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		2		2				do	2
27	Nov. 22, 1902		1	1				June 30, 1903	1
27	do		1	1				do	1
		1		1				do	1
		$177\frac{2}{3}$		$177\frac{2}{3}$	$177\frac{2}{3}$	Worn-out and worthless.		do	0
		2		2	2	do		do	0
		2		2	2	do		do	0
		2		2				do	2
		2		2				do	2
		2		2				do	2
		5		5				do	5
		4		4				do	4
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		2		2				do	2
		2		2				do	2
		8		8				do	8
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit	Total.	
SECOND FLOOR—continued.					
Southwest bedroom—Continued.					
Clock, black marble					
Ornaments, black marble, to accompany clock					
Vases, flower					
Photograph of President Arthur in gilt frame					
Engravings, in gilt frames					
Table, lacquered					
Vases, flower, cut glass					
Vase, flower					
Minor, brass, oval, easel back					
Lamp					
Shade, lamp, silk umbrella					
Slip covers					
Carpet, Wilton, velvet ... yards					
Covers, bureau					
Cover, dressing-case					
Cover, side-table					
Cover, table, plush					
Shams, pillow					
Quilt, bed					
Bed, brass					
Spring, box					
Pillow, hair					
Pad, desk					
Rack, paper, Dresden					
Rack, pen					
Inkstand					
Screen					
Basket, waste					
Scarf, bureau					
Supporters, book ... pair					
Blankets, Roman					
Shade, lamp					
Awnings, window					
Covers, loose					
Basket, waste, wooden					
Fender, brass					
Fire tools, brass, complete					
Bed, double, rosewood, carved					
Spring, double					
Mattresses, hair					
Bolster, feather					
Canopy, gilt, over bed					
Southwest dressing room.					
Rug, Wilton, green					
Carpet, Wilton ... yards					
Matting, white, China ... do					
Shades, white, Holland					
Shades, green					
Sofa, upholstered					
Chair, arm, upholstered					
Chairs, side, upholstered					
Seat, window, upholstered					
Pillows, sofa					
Bureau, rosewood					
Desk, writing, inlaid					
Basket, wooden, waste paper					
Fender, fire, brass					
Fire tools, brass, complete ... set					
Basket, grate, iron					
Sideboard top, oak					
Figures, bronze, storks					
Figure, bronze, pheasant					
Vases, flower					
Candlesticks, brass					
Statuette, bisque					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		2		2	1	Burned at place of storage.		do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		17		17	17	Worn-out and worthless.		do	0
		121		121				do	121
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By authority of the President.	do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		3		3				do	3
		2		2				do	2
		1		1				do	1
		2		2				do	2
		6		6				do	6
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		3		3				do	3
		1		1				do	1
		1	1	2				June 30, 1903.	2
		50		50	50	Made into rug (see above).		do	0
		38		38	38	Worn-out and worthless.		do	0
		3		3	3	do		do	0
		3		3	3	do		do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		5		5				do	5
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
SECOND FLOOR—continued.					
Southwest dressing room—Continued.					
Match safe, brass					
Match safe, bronze					
Bed, folding, walnut					
Mattresses, hair					
Pillows, feather					
Towel rack, wall					
Key, gas					
Toilet set, 3 pieces					
Dish, soap, silver-plated					
Mirror, mahogany					
Chair, walnut, cane					
Laces, renaissance ... pair					
Slip covers					
Screen, 4-fold, black					
Awnings, window					
Rugs, oriental					
Chiffonier, walnut					
Stand, shaving, mahogany					
Rack, towel, walnut					
Chairs, side, walnut, cane seats					
Wardrobe, walnut					
Clothes hamper					
Shade, white Holland					
Shades, green Holland	3	Nov. 20, 1902	$3.84	$11.52	A. E. Kennedy
Southwest bathroom.					
Mirror, antique					
Dish, soap					
Curtains, sash ... pair					
Upper corridor (second floor).					
Lace net for curtains ... yards	15	Nov. 13, 1902	.55	8.25	A. E. Kennedy
Lace net for curtains ... do	$16\frac{1}{3}$	do	.55	8.98	do
Silk, China ... do	30	do	.75	22.50	do
Curtains, silk and net ... pair	2	Nov. 25, 1902	14.50	29.00	do
Curtains, net ... do	2	Apr. 23, 1903		31.73	do
Carpet, Wilton, green ... yards					
Cabinets, ebonized					
Cabinets, mahogany					
Stands, mahogany, marble-top					
Table, mahogany, long					
Clock, mahogany, tall					
Chairs, arm, mahogany, upholstered in leather					
Chairs, arm, mahogany, upholstered satin damask.					
Chairs, side, mahogany, upholstered satin damask.					
Settees, mahogany, upholstered in leather					
Chairs, side, mahogany, upholstered in leather					
Screen, ebonized, 6-fold					
Seats, corner, upholstered in satin damask					
Pillows, sofa, covered with satin damask					
Mirror, tall, ebony frame					
Stand, mirror, ebony, marbletop					
Painting, oil, General Grant					
Engraving, Queen Victoria landing at Portsmouth.					
Bowl, covered, papier-maché					
Jardinieres, brass					
Vases, high, Italian marble					
Figure, bronze, woman with Cupid on shoulder					
Figure, bronze, woman with Cupid at feet					
Figure, bronze					
Jardiniere, bronze, low					
Table, ebony, marble top					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		2		2				do	2
		11		11	11	Worn-out and worthless.		do	0
		1		1				do	1
		3		3				do	3
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
27	Nov. 22, 1902	1	3	4				do	4
		1		1	1	Sold at auction	By order of the President.	June 30, 1903	0
		1		1				do	1
		3		3				do	3
20	Nov. 15, 1902		15	15				June 30, 1903	15
20	do		$16\frac{1}{3}$	$16\frac{1}{3}$				do	$16\frac{1}{3}$
27	Nov. 22, 1902		30	30				do	30
9	Dec. 13, 1902		2	2				do	2
13	May 2, 1903		2	2				do	2
			199	199	199	Made into rugs (see below).		do	0
			4	4	2	Burned at place of storage.		do	2
			2	2				do	2
			2	2				do	2
			1	1				do	1
			1	1				do	1
			2	2				do	2
		2		2				do	2
		4		4				do	4
		2		2				do	2
		2		2				do	2
		1		1				do	1
		2		2				do	2
		18		18				do	18
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1	1	do	do	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
SECOND FLOOR—continued.					
Upper corridor (second floor)—Continued.					
Table, ebony, square top					
Stand, ebony, carved					
Settee, upholstered in green satin damask					
Chairs, arm upholstered in green satin damask					
Seat, window, long					
Cushion, for long window seat, satin damask.					
Stand, high, mahogany					
Bookcase, revolving, walnut					
Chair, rocking, low, mahogany					
Chair, rocking, high, mahogany, cane seat					
Figure, bronze, woman with lyre					
Photograph, framed in oak, "Cathedral"					
Photograph, framed in oak, "Coliseum at Rome."					
Photograph, framed in oak, "Gladiator"					
Portierès ... pairs					
Drapers for bow window ... do					
Shades, green, Holland					
Covers, loose					
Vases, Hungarian ware					
Jardiniere, English					
Vase, flower, Dresden, 4 posts					
Table, round, mahogany					
Clock, mahogany					
Portrait, oil, President Millard Fillmore					
Portrait, oil, President James A. Garfield					
Chair, rocking, mahogany					
Pillows, down, covered with red velour					
Table, tea, mahogany					
Screen					
Table					
Shade, lamp					
Basket, music					
Lamp, B. and H., with shade					
Pail, slop					
Rugs, Wilton, with fringe					
Table, small, ebonized					
Table, carved, Flemish oak					
Rugs, made from carpet (see above)					
ELEVATOR HALLS.					
Carpet, Wilton, red ... yards					
Matting, white, china ... do					
Seats, upholstered					
ELEVATOR.					
Carpet, Wilton ... yards					
Matting, white, china ... do					
LANDINGS AND STAIRS.					
Carpet, Wilton ... yards					
Matting ... do					
Chairs, arm, rosewood, upholstered in leather.					
Stands, flower, wood, ebonized					
Table, walnut, marble-top					
Shade, white Holland					
Matting, white ... yards					
Box, for wood					
Rugs, made from carpet (see above)					
FIRST FLOOR.					
Pantry.					
Teapot	1	Feb. 10, 1903		$0.90	Dulin & Martin
Linoleum, inlaid ... yards					

Executive Mansion June 30, 1903—Continued.

Voucher. No.	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
		1		1				June 30, 1903	1
		1		1				do	1
		1		1				do	1
		6		6				do	6
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Burned at place of storage.		do	0
		1		1	1	do		do	0
		3		3	3	Worn-out and worthless.		do	0
		31		31	31	do		do	0
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	2
			2	2				do	2
		10		10				June 30, 1903.	10
		25⅓		25⅓				do	25⅓
		2		2				do	2
		3⅔		3⅔				June 30, 1903.	3⅔
		3⅔		3⅔				do	3⅔
		71½		71½	71½	Made into rugs (see below).		June 30, 1903	0
		114½		114½	71½	Worn-out and worthless.		do	43
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1	1	Worn-out and worthless.		do	0
		200		200				do	200
		1		1				do	1
			2	2				do	2
49	Mar. 23, 1903		1	1				June 30, 1903	1
		36		36	36	Worn-out and worthless.		do	0

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Pantry—Continued.					
Table, breakfast, walnut					
Table, long, mahogany					
Refrigerator, Jewett's					
Hamper, clothes, wicker					
Shades, window, white Holland					
Filter, small, Berkfield					
Clock, wooden, 8-day					
Kettle, tea, galvanized iron					
Chairs, wooden					
Ice shaver, galvanized iron					
Trays, japanned					
Canister, tea tin, japanned					
Towels, glass ... dozen					
Towels, roller ... do					
Tray, bed					
Knife, carving					
Fork, carving					
Knife, ham					
Refrigerator, nursery					
Steel, knife					
Tray, wood					
Chest, cake					
Boxes, sugar					
Corkscrew					
Squeezer, lemon					
Basket for silver					
Brushes for silver					
Curtains, sash ... pair					
Coffeepot, small, tin					
Private dining room.					
Curtains, velour, double-faced ... pair	2	July 3, 1902		$126.25	A. E. Kennedy.
Covers, sideboard ... dozen	2	July 12, 1902		50.00	Porto Rican Benevolent Society.
Goblets, cut-glass ... do	2	July 2, 1902	$65.00	130.00	The Van Heusen Charles Co.
Saucers, champagne, cut-glass ... do	$1\frac{1}{2}$	do	60.00	90.00	do
Glasses, claret, cut-glass ... do	$1\frac{1}{2}$	do	55.00	82.50	do
Glasses, cordial, cut-glass ... do	1	do		42.00	do
Glasses, punch, handled, cut-glass ... do	1	do		60.00	do
Plates, cut-glass ... do	$1\frac{1}{2}$	do	60.00	90.00	do
Finger bowls, cut-glass ... do	1	do		65.00	do
Teacups and saucers ... do	1	July 28, 1902		16.30	Gilman, Collamore & Co., New York.
Pitchers	12	Nov. 25, 1902		8.64	Dulin & Martin Co.
Matting ... yards					
Laces, Brussels ... pair					
Shades, white Holland					
Sideboards					
Tables, side, mahogany					
Cigar box, tin, square					
Lambrequin, mantel, covered with red damask.					
Fender, brass					
Fire set, brass, tongs, shovel, poker and stand.					
Andirons, brass					
Clock, black marble					
Candelabra, high, bronze and gilt					
Figure, bronze, antelope					
Kettle, tea, brass					
Stand, brass, for kettle					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
....	....	1	....	1	....	....	....	June 30, 1903	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	1	Sold at auction	By order of the President.	.....do......	0
....	....	1	....	1	....	....	....	.....do......	1
....	....	3	....	3	3	Worn-out and worthless.	....	.....do......	0
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	4	....	4	....	....	....	.....do......	4
....	....	1	....	1	....	....	....	.....do......	1
....	....	4	....	4	....	....	....	.....do......	4
....	....	1	....	1	....	....	....	.....do......	1
....	....	5	....	5	....	....	....	.....do......	5
....	....	2	....	2	....	....	....	.....do......	2
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	2	....	2	....	....	....	.....do......	2
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	2	....	2	....	....	....	.....do......	2
....	....	2	....	2	....	....	....	.....do......	2
....	....	1	....	1	....	....	....	.....do......	1
1	July 5, 1902	....	2	2	....	....	....	June 30, 1903	2
11	July 25, 1902	....	2	2	....	....	....	.....do......	2
14	.....do......	....	2	2	....	....	....	.....do......	2
14	.....do......	....	$1\frac{1}{2}$	$1\frac{1}{2}$	....	....	....	.....do......	$1\frac{1}{2}$
14	.....do......	....	$1\frac{1}{2}$	$1\frac{1}{2}$	....	....	....	.....do......	$1\frac{1}{2}$
14	.....do......	....	1	1	....	....	....	.....do......	1
14	.....do......	....	1	1	....	....	....	.....do......	1
14	.....do......	....	$1\frac{1}{2}$	$1\frac{1}{2}$	....	....	....	.....do......	$1\frac{1}{2}$
14	.....do......	....	1	1	....	....	....	.....do......	1
22	Sept. 23, 1902	....	1	1	....	....	....	.....do......	1
47	Dec. 24, 1902	....	12	12	....	....	....	.....do......	12
....	....	$161\frac{1}{3}$	....	$161\frac{1}{3}$	$115\frac{1}{3}$	Worn-out and worthless.	....	.....do......	46
....	....	2	....	2	2	Burned at place of storage.	....	.....do......	0
....	....	2	....	2	2	Worn-out and worthless.	....	.....do......	0
....	....	2	....	2	2	Sold at auction	By order of the President.	.....do......	0
....	....	2	....	2	....	....	....	.....do......	2
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	2	....	2	....	....	....	.....do......	2
....	....	1	....	1	....	....	....	.....do......	1
....	....	2	....	2	....	....	....	.....do......	2
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1
....	....	1	....	1	....	....	....	.....do......	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Private dining room—Continued.					
Vases, majolica					
Jardiniere, blue and white, paintings of birds on side.					
Jardiniere, Chinese					
Plate, Chinese					
Placque, forest scene, deer in the distance					
Placque					
Vase, yellow and white, with stand, English ware.					
Pitcher, fancy, blue, Hungarian ware					
Dishes, meat, silver plated					
Plates, ice-cream, cut-glass ... dozen					
Tablecloths, linen					
Napkins, linen ... dozen					
Doilies, linen ... do					
Tongs, sugar, silver ... pair					
Screens					
Cups, bouillon					
Table, pine					
Salt cellars, glass					
Spoons, salt					
Dishes, meat					
Dishes, bonbon					
Knives, fruit					
Dishes, oatmeal					
Pitchers, cut glass					
Cups, egg					
Knives					
Pitchers					
Curtains, sash ... pair					
Urn, bouillon, silver-plated					
Pitchers, glass					
Cloths, drawn work					
Basket, knife					
Goblets ... dozen					
Baskets					
Curtains, velour, used at receptions					
Saucers, bouillon					
Goblets, glass ... dozen		Feb. 14, 1903	$1.75	$5.25	Dulin & Martin Co.
Anteroom, or ushers' lobby.					
Water cooler	1	June 6, 1902		7.65	Dulin & Martin Co.
Cabinet, key	1	Feb. 15, 1903		2.10	A. E. Kennedy
Rugs, Turkish, 1 large, 3 small					
Shade, white, Holland					
Lambrequin, window					
Seat, carved, Flemish oak					
Chairs, side, carved, Flemish oak					
Chair, arm, carved, Flemish oak					
Andirons, wrought-iron ... pair					
Fender, wrought-iron					
Fender, spark, Russian iron					
Vases, Holland delft					
Painting, Rio de Janeiro Bay					
Shade, Holland					
Brush, hair					
Comb					
Mirror					
Button hook					
Shoehorn					
Basket, waste					
Desk, Flemish finish					
Main vestibule.					
Shades, window, white Holland					
Chairs, arm, walnut, large					

Executive Mansion June 30, 1903—Continued.

Voucher. No.	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
		2		2				June 30, 1903	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1	1	do	do	do	0
		1		1				do	1
		1		1				do	1
		4		4				do	4
		1		1				do	1
		2		2				do	2
		5		5				do	5
		4		4				do	4
		1		1				do	1
		2		2				do	2
		43		43				do	43
		1		1				do	1
		6		6				do	6
		12		12				do	12
		6		6				do	6
		2		2				do	2
		12		12				do	12
		12		12				do	12
		3		3				do	3
		12		12				do	12
		12		12				do	12
		12		12				do	12
		2		2				do	2
		1		1				do	1
		3		3				do	3
		4		4				do	4
		1		1				do	1
		3		3				do	3
		2		2				do	2
		43		43				June 30, 1903	43
49	Mar. 23, 1903	3		3				do	3
30	Sept. 23, 1902		1	1				June 30, 1903	1
12	Mar. 14, 1903		1	1				do	1
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		5		5	3	Worn-out and worthless.		June 30, 1903	2
		3		3				do	3

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Main vestibule—Continued.					
Trays, card, silver					
Chairs, oak					
Mats, cocoa					
Carpet, Wilton, green					
Matting .... yards					
Desk, walnut					
Detector, watchman's					
Chairs, oak, high back					
Portrait and frame, oil, President Roosevelt		Mar. 31, 1903		$2,500.00	W. D. Murphy, New York.
East Room.					
Carpet, Wilton, old gold .... yards					
Shades, window, white Holland					
Laces, Brussels .... pair					
Curtains, heavy, satin damask .... do					
Divan, reupholstered in satin damask					
Chairs, side, reupholstered in satin damask					
Chairs, corner, reupholstered in satin damask					
Chairs, arm, reupholstered in satin damask					
Covers, loose					
Painting, President Washington					
Painting, President Thomas Jefferson					
Painting, President Lincoln					
Painting, Mrs. Martha Washington					
Carpet, Wilton, velvet .... yards					
Matting, straw .... do					
Table top, white pine					
Crash, floor, linen .... yards					
Green Parlor.					
Andirons .... pair	1	May 22, 1903		185.00	L. Marcotte & Co., New York
Cover, wall, cotton damask		Apr. 11, 1903		94.95	A. E. Kennedy
Shades, window, white Holland					
Laces, window, Renaissance .... pair					
Draperies, window, green satin damask .... do					
Piano, Knabe, concert grand					
Sofa, upholstered, green satin damask					
Chairs, arm, upholstered, green satin damask all over.					
Chairs, upholstered, green satin damask all over.					
Ottoman, upholstered in satin damask all over.					
Seat, tête-à-tête, circular, upholstered as above					
Stool, piano, upholstered					
Cabinet, carved mahogany, tall					
Mirror, over mantelpiece, gilded wood with United States shield over center at top.					
Mirror, on console table, gilded wood with United States shield over center at top.					
Cabinet, stand and cabinet combined, about 3 feet high, Japanese or Chinese, lacquered and ornamented in gilt.					
Vases, Japanese, about 3 feet high, in carved teak wood bases.					
Andirons, brass					
Fender, brass, low, open					
Fire screen, brass and green damask					
Fire screen, silk, embroidered United States coat of arms behind glass in black frame.					
Music stand, gilt wood, presented by Austrian minister.					
Statuette, bronze, Diane de Cabies					
Clock, bronze and onyx					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No	Date.							Date.	Quantity.
		6		6				June 30, 1903	6
		4		4				do	4
		2		2				do	2
								do	
		240		240				do	240
		1		1				do	1
		1		1				do	1
		4		4				do	4
66	Mar. 31, 1903		1	1				do	1
		476		476				June 30, 1903	476
		15		15	9	Worn-out, worthless.		do	6
		9		9	6	Burned at place of storage.		do	3
		9		9				do	9
		1		1	1	Sold at auction	By order of the President.	do	0
		12		12				do	12
		4		4				do	4
		8		8				do	8
		30		30	30	Worn-out and worthless.		do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		513¼		513¼				do	513¼
		378		378				do	378
		1		1				do	1
		366		366				do	366
55	June 23, 1903		1	1				June 30, 1903	1
			1	1				do	1
		2		2	2	Worn-out and worthless.		do	0
		2		2				do	2
		2		2	2	Burned at place of storage.		do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2	2	Damaged and worthless.		do	0
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Green parlor—Continued.					
Vase, pink crown derby					
Vase, yellow crown derby					
Vase, decorated in gold; of porcelain Sevres; no handle; picture of alpine village on banks of a mountain torrent; one high and one low bridge.					
Vase, same, but picture of seaport; mountains in background, in foreground a peasant driving cattle, woman in red sitting on bench; child in blue and red standing by woman (to the right).					
Oil painting, portrait, President Buchanan					
Oil painting, portrait, President Jackson					
Oil painting, portrait, President Van Buren					
Oil painting, portrait, President Arthur					
Oil painting, portrait, President Taylor					
Table, console, gilded wood, marble top, under mirror.					
Laces, Brussels, extra long ....pair					
Shades, window					
Chairs, antique					
Lamp, students', double, Colonial					
Table, tea, mahogany					
Screen, black, 4-fold					
Cushions, antique					
Lamp, bronze					
Shade, lamp, pink-lined					
Covers, loose					
Oil painting, portrait John Quincy Adams					
Oil painting, portrait Franklin Pierce					
Oil painting, portrait Andrew Johnson					
Oil painting, portrait Andrew Jackson					
Oil painting, portrait Wm. Henry Harrison					
Oil painting, portrait John Adams					
Blue parlor.					
Andirons ....pair	1	May 22, 1903		$100.00	L. Marcotte & Co., New York.
Cover, wall, cotton damask	1	Apr. 11, 1903		94.95	A. E. Kennedy.
Carpet, Wilton, solid color, gray blue..yards					
Matting, white china, under carpet....do					
Shades, window, Holland, white					
Shades, window, Holland, light blue					
Curtains, lace, Renaissance ....pair					
Draperies, window, blue satin damask borders, pair.					
Chair, ottoman, upholstered in blue damask					
Ottomans, gilded wood frames and legs, upholstered in blue damask.					
Hassock, Wilton, to match carpet					
Andirons, brass					
Fender, brass, low					
Covers, furniture					
Covers, wall					
Candelabra, 5 feet, gilded bronze, 12 branches in 2 horizontal planes of 6 each, 1 central projecting branch, tripod bases.					
Clock, mantel, gilded bronze. Longitudinal pedestal about 20 by 8 inches; sides covered with bas-reliefs of Roman trophies. On the pedestal a seated female figure, probably Goddess of War or Victory; has a Roman helmet on her head and a wreath in left hand. Made by "Thomière & Cie.;" also marked at bottom of dial "Monier Ainé."					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		1		1				do	1
		1		1	1	Damaged and worthless.		do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		3		3				do	3
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		6		6				do	6
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
55	June 23, 1903		1	1				June 30, 1903	1
			1	1				do	1
		161⅓		161⅓				do	161⅓
		161⅓		161⅓	161⅓	Worn-out and worthless.		do	0
		3		3	3	do		do	0
		3		3	3	do		do	0
		3		3				do	3
		3		3	3	Burned at place of storage.		do	0
		1		1				do	1
		2		2				do	2
		1		1	1	Damaged and worthless.		do	0
		2		2	2	do		do	0
		1		1	1	do		do	0
		30		30				do	30
		15		15				do	15
		2		2				do	2
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Blue parlor—Continued.					
Candlesticks, mantel, gilded bronze, 2 feet high, probably companions of clock. Square pedestals on 4 claw feet; winged female figures on two sides of pedestal carrying wreath in one hand and trumpet or quill pen in other.	....	....	....	....	....
Vases, dark-blue Sevres, presented by President Faure, of France, to President McKinley.	....	....	....	....	....
Pedestals, decorated wood, for above vases...	....	....	....	....	....
Pillows, or cushions, in blue satin damask....	....	....	....	....	....
Mirror, on gilded-wood console table..........	....	....	....	....	....
Vases, gilded porcelain, each on a square base in two steps. Each has two handles, which are swans' necks and heads. One has a picture of blind old man carrying youth on left arm, staff in right, helmet hanging from belt. The other has a picture of blind old man and youth standing on rock overlooking sea; a lyre hangs from old man's back.	....	....	....	....	....
Vase, corrugated white porcelain, overlaid with pond lilies of same. Base is gilded, marked Moore (O)	....	....	....	....	....
Red Parlor.					
Cover, wall, cotton damask..................	1	Apr. 11, 1903	....	94.95	A. E. Kennedy..
Matting, white China ....yards..	....	....	....	....	....
Draperies, window, red damask, white figure, pair.	....	....	....	....	....
Laces, window ....pair..	....	....	....	....	....
Shades, window, white Holland	....	....	....	....	....
Table, rectangular, mahogany, carved	....	....	....	....	....
Table, square, mahogany	....	....	....	....	....
Cabinets, mahogany	....	....	....	....	....
Bookcase, mahogany	....	....	....	....	....
Screen, fire, gilt. Gilded wood surmounted by eagle, silk embroidered center, surrounded by 4 cat o' nine tails, showing fireplace in background; man sitting in center before a table carrying the Bible, man kneeling on his right, three females standing behind him, a male and female servant standing on extreme right of picture.	....	....	....	....	....
Screen, fire, brass, brass frame, damask center.	....	....	....	....	....
Andirons, brass	....	....	....	....	....
Fire tools, steel, brass handles, 4 pieces...set..	....	....	....	....	....
Mantelpiece, mahogany	....	....	....	....	....
Vases (Faience) with ebony bases, about 4 feet high. One has painting of "Cupid in Prison," with Roman girl in front of door on one side, on other side a vase on a pedestal, with a fountain and ionic portico in background. The other has on one side a Roman girl drinking at a tall fountain, 2 doves; on the other side a fluted pillar carrying a fountain bowl containing a dolphin with a corinthian portico in background.	....	....	....	....	....
Stands for above, ebony......................	....	....	....	....	....
Curtain, damask for bookcase	....	....	....	....	....
Covers, table, damask	....	....	....	....	....

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
....	....	2	....	2	....	....	....	June 30, 1903	2
....	....	2	....	2	....	....	....	.....do	2
....	....	2	....	2	2	Sold at auction....	By order of the President.	.....do	0
....	....	4	....	4	....	....	....	.....do	4
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	1	....	1	....	....	....	.....do	1
....	....	....	1	1	....	....	....	June 30, 1903	1
....	....	$197\frac{1}{3}$	....	$197\frac{1}{3}$	$109\frac{1}{3}$	Worn-out and worthless.	....	.....do	88
....	....	2	....	2	2	Burned at place of storage.	....	.....do	0
....	....	2	....	2	....	....	....	.....do	2
....	....	4	....	4	4	Worn-out and worthless.	....	.....do	0
....	....	1	....	1	1	Burned at place of storage.	....	.....do	0
....	....	1	....	1	1	.....do............	....	.....do	0
....	....	2	....	2	2	.....do............	....	.....do	0
....	....	1	....	1	1	Sold at auction ...	By order of the President.	.....do	0
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	2	Damaged and worthless.	....	.....do	0
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	2	....	2	....	....	....	.....do.	2
....	....	1	....	1	1	Burned at place of storage.	....	.....do	0
....	....	2	....	2	2	.....do............	....	.....do	0

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
FIRST FLOOR—continued.					
Red parlor—Continued.					
Lamp, duplex burner for kerosene, cut glass, with globe.					
Fender, brass					
Clock, gilt. On top a Roman sword and bowl of rings. At one side is a Roman warrior, etc.					
Vases, gilt. Companion pieces to above clock					
Placque, oval, painted, finished in ultramarine and gold. Picture of a lady standing against table; two cavaliers, one standing with hat on, one bowing.					
Candelabra, tall, bronze gilt, female figure standing on a globe. Five branches and one center branch. Pedestals have bas relief, Roman trophy.					
Stand, gilded wood, marble top, 4 feet high					
Jardinièr, green, marked on bottom ₸₸ 207					
Vases, porcelain, magenta and gold, bracket arms. Each has a picture of French Revolutionary times.					
Ewer, green and gilt. Ewer has (1) Venus riding a dolphin, three armors. (2) Venus riding a dolphin and looking in hand glass. (3) Armors, one with bow and arrow.					
Basin has (1) Neptune riding the sea. (2) Venus driving a dolphin, accompanied by a nymph.					
Bronze groupe. Male figure seated on base of a broken pillar; female figure with face turned away; her right hand in right hand of the man, his left hand on hei left shoulder. Marked "Morcan."					
Bronze figure, soldier seated; ancient armor; boar's or bear's hand helmet; left elbow resting on a casket on his left knee marked "R tion—Sauvage."					
Bronze figure, ancient warrior, seated, bareheaded, battle-ax or scepter across knees.					
Settee, gilded wood, upholstered in red satin damask.					
Chairs, arm, rosewood, upholstered in red satin damask.					
Chairs, side, rosewood, upholstered in red satin damask.					
Chairs, arm, mahogany, upholstered in striped silk.					
Chairs, arm, gilded wood, upholstered in red satin damask.					
Chairs, side, ditto, as above					
Stand, table, brass, $3\frac{1}{2}$ feet high, top onyx					
Mirrors, mahogany frames					
Table, mahogany, rectangular					
Portrait, oil, President Polk					
Portrait, oil, President Tyler					
Portrait, oil, President Hayes					
Portrait, oil, President Harrison					
Portrait, oil, Mrs. Polk					
Portrait, oil, Mrs. Tyler					
Portrait, oil, Mrs. Van Buren					
Portrait, oil, Mrs. Hayes					
Portrait, oil, Mrs. Harrison					
Vase, white and gold, cactus in bloom					
Carpet, Wilton, velvet ... yards					
Chair, antique					
Shade, silk					
Lamp, B. and H					
Chair, rocking					
Sofa, "Durham"					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
....	....	1	....	1	1	Sold at auction....	By order of the President.	June 30, 1903	0
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	2	....	2	....	....	....	....do	2
....	....	1	....	1	1	Sold at auction....	By order of the President.	....do	0
....	....	2	....	2	....	....	....	....do	2
....	....	1	....	1	1	Burned at place of storage.	....	....do	0
....	....	1	....	1	....	....	....	....do	1
....	....	2	....	2	....	....	....	....do	2
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	2	....	2	....	....	....	....do	2
....	....	4	....	4	....	....	....	....do	4
....	....	1	....	1	....	....	....	....do	1
....	....	2	....	2	....	....	....	....do	2
....	....	2	....	2	....	....	....	....do	2
....	....	1	....	1	1	Burned at place of storage.	....	....do	0
....	....	2	....	2	2	....do	....	....do	0
....	....	1	....	1	1	....do	....	....do	0
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	20	....	20	....	....	....	....do	20
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	....	....	....	....do	1
....	....	1	....	1	1	Sold at auction....	By order of the President.	....do	0

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Red Parlor—Continued.					
Globe, lamp					
Screen, 4-fold, black					
Pole, curtain, brass, with rings					
Portrait, oil, President Zachary Taylor					
Portrait, oil, President James Monroe					
Portrait, oil, President Thomas Jefferson					
Portrait, oil, President James Madison					
Engraving, President Washington					
Portrait, oil, President Washington					
Portrait, oil, President Grant					
State dining room.					
Carpet, red, Wilton ... yards					
Matting, white, China ... do					
Draperies, old gold damask ... pair					
Laces, renaissance ... do					
Shades, white, Holland					
Sideboards, walnut					
Tables, side, walnut					
Chairs, mahogany, upholstered in leather					
Chairs, rosewood, upholstered in leather					
Urn, China, decorated					
Table, breakfast, walnut					
Table, pine top					
Candelabra, gilt, 11 lights					
Stands, gilt, tall					
Holders, cut-glass					
Group, bronze, pheasant with young					
Mirrors, gilt					
Plateau, in 7 pieces, gilt mirror frame					
Figures, gilt, women with wreaths					
Ornaments, gilt, used with plateau					
Pitchers					
Table, oval, large, pine					
Screens, window					
Table, dining, round, mahogany					
Main corridor.					
Matting, white China ... yards					
Portieres, plush, old gold ... pair					
Mirrors					
Stands, flower, covered in red plush					
Pedestals, covered in red plush					
Pedestal, marble and plaster					
Bust, marble, President Fillmore					
Bust, marble, Hon. John Bright					
Bust, marble, Judge Jay					
Bust, marble, Unknown					
Bust, marble, Americus					
Jardinieres, majolica ware					
Portrait, oil, Grover Cleveland					
Covers, loose ... pieces					
Pedestal, plush-covered					
Mirror, walnut frame					
Table, marble top, round					
Table, marble top, mahogany					
Stands, marble, high					
Chairs, horn, upholstered					
Lamp, bronze					
Shade, red silk					
Cabinets, mahogany					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		178		178				June 30, 1903	178
		178		178	178	Worn-out and worthless.		do	0
		5		5				do	5
		5		5				do	5
		5		5				do	5
		2		2	2	Sold at auction	By order of the President.	do	0
		4		4				do	4
		40		40				do	40
		15		15				do	15
		1		1	1	Damaged and worthless.		do	0
		1		1				do	1
		1		1				do	1
		4		4				do	4
		5		5				do	5
		32		32				do	32
		1		1				do	1
		3		3	1	Sold at auction	By order of the President.	do	2
		1		1				do	1
		16		16				do	16
		20		20				do	20
		2		2				do	2
		1		1				do	1
		3		3				do	3
		1		1				do	1
		559		559	247	Worn out and worthless.		June 30, 1903	312
		1		1	1	Burned at place of storage.		do	0
		2		2	2	Sold at auction	By order of the President.	do	0
		2		2				do	2
		4		4				do	4
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		10		10				do	10
		1		1				do	1
		6		6	6	Worn-out and worthless.		do	0
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2				do	2

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Main corridor—Continued.					
Cabinets, ebonized					
Jardinieres, Chinese					
Screen, mahogany, five-fold					
Tables, mahogany, small					
Chairs, arm, mahogany, upholstered					
Chair, arm					
Stands, flower, wooden, stained					
Urns, brass					
Rocker, mahogany, high back					
Engraving, President Garfield					
South Portico.					
Rug, carpet, velvet	1	June 1, 1903		$81.00	A. E. Kennedy.
Awning, reed	1	May 5, 1903		10.10	do
Awnings, window	5	Apr. 10, 1903	$15	75.00	do
Curtains, drop, canvas					
Chair, reclining					
Shade, lawn, with platform					
BASEMENT.					
Steward's room.					
Carpet, Wilton, brown ... yards					
Matting, white, china ... do					
Shades, Holland, gray					
Desk, small, walnut					
Table, walnut, with drawer					
Table, walnut, marble top					
Wardrobe, mahogany					
Washstand, walnut					
Table, small, walnut					
Chair, office, revolving					
Chair, oak, cane seat					
Table, oak, extension					
Fender, brass					
Stove, coal, Ore No. 4					
Chairs, arm, upholstered in green rep					
Settee, upholstered in leather					
Safe, office, Farrell, Herring & Co					
Candle holders, patent, plated					
Boxes for candle holders					
Toilet set, 4 pieces					
Stand, umbrella, china, blue and white					
Light, drop, brass, electric					
Fire extinguishers, glass bulbs					
Mirror, walnut frame					
Box, shoe-blacking, walnut					
Pillow, leather					
Basket, waste-paper					
Chair, low, walnut					
Clock, regulator, 8-day, mahogany					
Clock, cherry, 8-day					
Rugs, camel's-hair					
Bobashers, glass					
Shades, paper, red and silver					
Shades, paper, pink and silver					
Shades, paper, yellow and silver					
Shades, silk, red					
Shades, silk, yellow					
Shades, silk, pink					
Stretcher, carpet, wooden handle					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		2		2				June 30, 1903	2
		4		4				do	4
		1		1				do	1
		2		2				do	2
		4		4				do	4
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
52	June 20, 1903		1	1				June 30, 1903	1
18	May 14, 1903		1	1				do	1
21	Apr. 18, 1903	5	5	10				do	10
		2		2				do	2
		1		1				do	1
		1		1				do	1
		88$\frac{2}{3}$		88$\frac{2}{3}$				June 30, 1903	88$\frac{2}{3}$
		88$\frac{2}{3}$		88$\frac{2}{3}$				do	88$\frac{2}{3}$
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		120		120				do	120
		10		10				do	10
		4		4				do	4
		1		1	1	Damaged and worthless.		do	0
		1		1	1	Worn-out and worthless.		do	0
		3		3	3	Damaged and worthless.		do	0
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		64		64				do	64
		101		101	3	Burned at place of storage.		do	98
		106		106	6	do		do	100
		20		20				do	20
		125		125				do	125
		131		131	1	Burned at place of storage.		do	130
		123		123	2	do		do	121
		1		1	1	Worn-out and worthless.		do	0

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Steward's room—Continued.					
Shades, white, Holland ... lot					
Scarf, blue satin damask					
Cover, table, red and white					
Cover, table, red and gold					
Cover, piano, blue					
Cover, piano, linen					
Curtains, lace ... pair					
Cover, table, for dining room					
Rugs, domestic					
Clock, brass, out of order					
Covers, slip, old ... lot					
Pitchers, water, toilet					
Jars, slop, toilet					
Tub, foot, china, toilet					
Toilet set, 7 pieces					
Plates, fish, Hayes set					
Plates, salad, Hayes set					
Plates, oyster, Hayes set					
Plates, game, Hayes set					
Plates, dinner, Hayes set					
Plates, soup, Hayes set					
Saucers, coffee, Hayes set					
Cups, coffee, Hayes set					
Cups, after dinner coffee, Hayes set					
Saucers, after dinner coffee, Hayes set					
Plates, dinner, Lincoln set					
Plates, soup, Lincoln set					
Plates, soup, small, Lincoln set					
Plates, breakfast, Lincoln set					
Plates, bread and butter, Lincoln set					
Plates, small, Haviland, odd					
Plates, ice cream, Haviland, pink					
Plates, soup, small, white china					
Plates, tea, white china					
Saucers, white, hotel china					
Cups, white, hotel china					
Plates, butter, individual, odd					
Lamp, student's, brass					
Drop lights, gas					
Shades, lamp, odd					
Lamps, oil, brass					
Cuspidors, china					
Rings, copper					
Curtains, creton ... pair					
Tin pyramid					
Trunks, for storing silver					
Pail, garbage					
Buckets, water, galvanized					
Box, walnut, for storing silver					
Trays, walnut					
Bowl, cracker and cheese, china, with top					
Plate warmer, japanned					
Jar, glass, large, with top					
Brass foot, for lamp					
Lamp, piano, brass					
Bread box, tin					
Shovels, coal, small					
Sweepers, carpet					
Boiler, wash, tin					
Stands, wooden, used in kitchen					
Trays, japanned, large					
Box, tin, for sugar; holds 50 pounds					
Trays, serving, wooden					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1	1	Worn-out and worthless.		June 30, 1903	0
		1		1	1	Damaged and worthless.		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		1		1				do	0
		1		1				do	1
		7		7	7	Worn out and worthless.		do	1
		1		1	1	do		do	0
		4		4	4	do		do	0
		1		1				do	0
		1		1	1	Worn out and worthless.		do	1
		3		3	3	Damaged and worthless.		do	0
		2		2	2	do		do	0
		1		1				do	1
		1		1				do	1
		38		38				do	38
		34		34				do	34
		37		37				do	37
		7		7				do	7
		24		24				do	24
		5		5				do	5
		23		23				do	23
		2		2				do	2
		6		6	2	Damaged and worthless.		do	4
		29		29	1	do		do	28
		55		55				do	55
		14		14				do	14
		6		6				do	6
		10		10				do	10
		2		2				do	2
		45		45				do	45
		6		6				do	6
		6		6				do	6
		14		14	1	Damaged and worthless.		do	13
		35		35	23	do		do	12
		19		19				do	19
		16		16				do	16
		1		1	1	Damaged and worthless.		do	0
		2		2	2	do		do	0
		13		13	13	do		do	0
		4		4	4	do		do	0
		2		2	2	do		do	0
		15		15	15	do		do	0
		1		1				do	1
		1		1				do	1
		6		6				do	6
		1		1	1	Damaged and worthless.		do	0
		5		5	3	do		do	2
		1		1				do	1
		3		3				do	3
		1		1	1	Damaged and worthless.		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		4		4	4	do		do	0
		5		5	5	do		do	0
		1		1	1	do		do	0
		15		15				do	15
		5		5				do	5
		1		1				do	1
		2		2				do	2

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Steward's room—Continued.					
Chair, wooden					
Funnels, tin					
Washboard					
Castors, old ... lot					
Rat-trap, wire					
Megaphones, used at receptions					
Stand, umbrella, china, blue and white					
Castors, Victor ... sets					
Brackets, brass, used to tie back curtains					
Cutter, for billiard cues					
Tip set, for billiard cues					
Marking pot, tin					
Shades, mica					
Figures, rubber-stamp					
Stencils, brass					
Spoons, wooden					
Spoon, iron					
Sways, left from decorating Blue Parlor ... lot					
Bed, walnut, double					
Carriers, tin, hot-water					
Keyboard					
Can, water					
Curtains, lace, Brussels ... pair					
Silver trunks—Trunk No. 1.					
(Marked M. le Baron de Tuyll. Wooden trunk covered with leather, bound with iron.)					
Tureen, soup, stand, inside and top. Made in France by Christopher. The mark on this silver was first used in 1797. All the silver is marked President's House.					
Platter, large, fancy border					
Platter, medium, fancy border					
Plate, fancy border — French plate					
Plates, thread border					
Chocolate pot, thread border					
Caster, wine, thread border — Silver					
Casters, salt, for 2 cellars, French plate					
Dishes, vegetable, round, with handles					
Casters, wine, fancy border					
Sifter, sugar, thread pattern					
Spoons, ice cream					
Forks, breakfast, beaded pattern, silver. They were made during Cleveland's second Administration from 84 silver forks and 57 gilt forks that were worn down. These forks were taken to the Treasury Department, weighed and melted. The silver was then sent to the silversmith's and 96 breakfast and 96 dinner forks made					
Spoons, tea, thread pattern, silver					
Knives, fruit, pear handles, with gilt, shield in handle. Gilt					
Spoon, mustard, without handle. Gilt					
Trunk, oak, bound with iron, brass plate, marked James Monroe					
Trays, scalloped edge. English plate					
Plates, fancy border, made by Christopher. His mark was first used in 1797. French plate.					
Platters, French plate, made by Christopher, thread pattern.					
Mug and stand, sirup, plated, marked "President s House."					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		5		5	5	Damaged and worthless.		do	0
		1		1	1	do		do	0
		4		4	4	do		do	0
		5		5	5	do		do	0
		1		1	1	do		do	0
		1		1	1	do		do	0
		1		1				do	1
		124		124	124	Damaged and worthless.		do	0
		1		1	1	Worn-out and worthless.		do	0
		4		4	4	do		do	0
		2		2	2	do		do	0
		1		1	1	Damaged and worthless.		do	0
		1		1	1	do		do	0
		1		1				do	1
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				June 30, 1903	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		5		5				do	5
		1		1				do	1
		1		1				do	1
		4		4				do	4
		2		2				do	2
		9		9				do	9
		1		1				do	1
		2		2				do	2
		95		95				do	95
		47		47				do	47
		47		47				do	47
		1		1				do	1
		1		1				do	1
		4		4				do	4
		19		19				do	19
		3		3				do	3
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
BASEMENT—continued.					
Silver trunks—Trunk No. 1—Continued.					
Caster, egg, 6 cups and 6 spoons					
Casters, wine, silver, handle, openwork					
Casters, wine, silver					
Caster, wine, plated; will hold 3 decanters					
Skewers, attelettes, 3 eagle and 3 squirrel tops					
Baking shells, shaped like scalloped shells, plated.					
Cheese scoop, celluloid handle, plated					
Knives, pearl handles, English, plated					
Knives, pearl handles, English, plated					
Knives, celluloid handles, plated					
Serving trays, fancy border, openwork, Gorham plate.					
Pans, crumb, plated, thread border					
Scrapers, crumb, plated, thread border					
Bouquet holders, leaf pattern, made by Meriden Britannia Co.					
Platters, beaded border, Gorham plate					
Baskets, cake, without handles, English plate					
Buckets, ice, with handle					
Bell, with black marble					
Bell, small, iron bottom					
Dishes, pudding, with rings					
Spoons, table, thread border, silver					
Spoons, table, silver, thread border					
Spoons, table, silver, thread border					
Forks, dinner, silver, beaded border					
Forks, breakfast, silver, beaded border					
Forks, oyster, silver, plain handle					
Forks, oyster, silver					
Sugar sifter, silver, thread pattern, Christopher.					
Tongs, sugar, gilt, fancy border, Christopher, pair.					
Scissors, grape, silver, pair					
Forks, salad, beaded pattern, silver					
Spoons, salad, beaded pattern, silver					
Spoons, tea, thread pattern. These were originally gilt, French silver.					
Spoons, tea, thread pattern, silver					
Spoons, tea, thread pattern, silver					
Spoons, after-dinner coffee, thread pattern					
Spoons, after-dinner coffee, thread pattern					
Spoons, berry, fancy border, silver					
Spoons, salad, thread pattern, silver					
Forks, salad, thread pattern, silver					
Rings, napkin, Nos. 1 to 6, silver					
Scraper, crumb, thread pattern, silver					
Mustard pots, French silver, made by Christopher.					
Dishes, vegetable, round, with handles, silver					
Cigar lighter, low, silver					
Cigar lighter, high, buckhorn handle, silver					
Cruets, pepper, 3 for black and 3 for red pepper, tall, silver.					
Forks, asparagus, combination silver					
Fork and spoon, combined, silver, for salad					
Knives, butter, thread pattern					
Knife, butter, thread pattern					
Extinguisher, candle, silver					
Porcupine, silver, for toothpicks					
Spoons, ice cream, fancy pattern handle					
Ship, silver, "Hiawatha"					
Lake for ship, silver					
Spoons, dessert, thread pattern, French gilt					
Spoons, gilt, dessert, thread pattern					
Spoons, gilt, dessert, thread pattern					
Strainer, tea					
Spoons, mustard, gilt, thread pattern					
Spoon, mustard, gilt, very slender					
Trunk, canvas-covered and bound with iron, marked "President's House."					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		2		2				do	2
		4		4				do	4
		1		1				do	1
		6		6				do	6
		6		6				do	6
		1		1				do	1
		89		89				do	89
		15		15				do	15
		108		108				do	108
		4		4				do	4
		6		6				do	6
		6		6				do	6
		38		38				do	38
		6		6				do	6
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		2		2				do	2
		57		57				do	57
		23		23				do	23
		12		12				do	12
		84		84				do	84
		72		72				do	72
		70		70	1	Lost		do	69
		12		12				do	12
		1		1				do	1
		1		1				do	1
		2		2				do	2
		4		4				do	4
		4		4				do	4
		36		36				do	36
		29		29				do	29
		24		24				do	24
		59		59				do	59
		24		24				do	24
		2		2				do	2
		2		2				do	2
		2		2				do	2
		6		6				do	6
		1		1				do	1
		2		2				do	2
		2		2				do	2
		1		1				do	1
		1		1				do	1
		12		12				do	12
		2		2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		57		57				do	57
		10		10				do	10
		12		12				do	12
		1		1				do	1
		8		8				do	8
		1		1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Silver trunks—Trunk No. 1—Continued.					
Bowls, salad, silver, fancy borders					
Bowls, salad, silver, Gorham, beaded pattern.					
Bowls, salad, silver, Gorham, beaded pattern.					
Dishes, olive, silver, fancy border					
Candelabra, silver, 5 lights					
Bowls, sugar, 1 has a top					
Pitcher, cream, French silver, tall					
Pitcher, cream, silver, thread border					
Tea set, 4 pieces for tray					
Compotes, silver, fancy border					
Coffeepots, French silver, ivory handles					
Teapot, ivory handle, French silver					
Teapot, silver, ebony handle					
Sauce boats, thread border, silver					
Stands, thread border, silver					
Tongs, sugar, silver, thread pattern					
Ladles, sauce, silver, thread pattern					
Ladles, sauce, silver, beaded pattern					
Ladles, soup, silver, thread pattern					
Knife, pie, silver, beaded pattern					
Dishes, bonbon, silver, Gorham, fancy border.					
Dishes, bonbon, silver, Gorham, openwork border.					
Dishes, bonbon, gilt, fancy border					
Spoons, serving, French silver, thread border.					
Kettle and stand, tea, silver, with eagle ornamental handle; kettle is made to tip.					
Compotes, silver, fancy border, openwork					
Toast rack, silver					
Toast rack, silver plated					
Trunk, wooden, covered with leather, ironbound, brass plate marked "No. 2, M. le Baron de Tuyll."					
Tureen, soup, stand, inside and top marked "President's house."					
Platter, French-plated, large, fancy border					
Platters, French-plated, medium, thread border.					
Plates, French plated, thread border					
Pitcher, cream, silver, ivory handle					
Pot, hot water, silver, ivory handle					
Caster, wine, silver, thread border, for 2 decanters.					
Casters, salt, French plated, for 2 cellars each.					
Knives, fruit, gilt					
Sifter, sugar, thread pattern, gilt					
Spoons, berry, gilt, thread pattern					
Forks, dinner, silver, beaded pattern					
Dishes, vegetable, silver, round, with handle on the side.					
Casters, wine, silver, fancy border					
Spoons, salt, gilt, thread pattern					
Trunk, covered with leather and bound with iron. Has brass plate marked Baron de Tuyll.					
Casters, wine, silver, fancy borders, with tops.					
Trunk, covered with black leather and bound with iron.					
Tureens, soup, silver, 3 parts each stand, inside and top. Top has eagle ornament for a handle.					
Silver-plated ware.					
Spoons, table					
Spoons, tea, German silver					
Spoons, tea, stamped "President's House"					
Forks, stamped "President's House"					
Knives, ivory handles					
Knives, plated handles					
Trays with handles, large, English plate, marked "President's House."					

Executive Mansion June 30, 1903—Continued.

Voucher. No.	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
...	...	2	...	2	...	...	...	June 30, 1903	2
...	...	2	...	2	...	...	...	do	2
...	...	2	...	2	...	...	...	do	2
...	...	2	...	2	...	...	...	do	2
...	...	4	...	4	...	...	...	do	4
...	...	2	...	2	...	...	...	do	2
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	6	...	6	...	...	...	do	6
...	...	2	...	2	...	...	...	do	2
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	4	...	4	...	...	...	do	4
...	...	4	...	4	...	...	...	do	4
...	...	2	...	2	...	...	...	do	2
...	...	5	...	5	...	...	...	do	5
...	...	2	...	2	...	...	...	do	2
...	...	3	...	3	...	...	...	do	3
...	...	1	...	1	...	...	...	do	1
...	...	12	...	12	...	...	...	do	12
...	...	12	...	12	...	...	...	do	12
...	...	12	...	12	...	...	...	do	12
...	...	8	...	8	...	...	...	do	8
...	...	1	...	1	...	...	...	do	1
...	...	4	...	4	...	...	...	do	4
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	2	...	2	...	...	...	do	2
...	...	5	...	5	...	...	...	do	5
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	1	...	1	...	...	...	do	1
...	...	4	...	4	...	...	...	do	4
...	...	48	...	48	...	...	...	do	48
...	...	1	...	1	...	...	...	do	1
...	...	2	...	2	...	...	...	do	2
...	...	96	...	96	1	Lost	...	do	95
...	...	2	...	2	...	...	...	do	2
...	...	11	...	11	...	...	...	do	11
...	...	10	...	10	...	...	...	do	10
...	...	1	...	1	...	...	...	do	1
...	...	4	...	4	...	...	...	do	4
...	...	1	...	1	...	...	...	do	1
...	...	2	...	2	...	...	...	do	2
...	...	32	...	32	...	...	...	June 30, 1903	32
...	...	8	...	8	...	...	...	do	8
...	...	291	...	291	...	...	...	do	291
...	...	300	...	300	...	...	...	do	300
...	...	38	...	38	...	...	...	do	38
...	...	19	...	19	...	...	...	do	19
...	...	2	...	2	...	...	...	do	2

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
BASEMENT—continued.					
Silver-plated ware—Continued.					
Candelabra, 5 lights, Gorham plate					
Candelabra, 5 lights					
Pot, coffee, international					
Dishes, butter					
Casters, wine					
Casters, table					
Dish, chafing					
Pitchers, water					
Pitchers, water, fancy border					
Pitchers, water, large, plain					
Trays for pitchers					
Trays for pitchers, fancy border					
Tea set for tray, plain					
Stand, tall, for bouquet holder					
Candlestick, plain					
Holders, ramakin					
Nutcrackers					
Lamps, spirit					
Nut pickers, pearl handles					
Nut pickers, plated handles					
Urn, coffee, capacity 3 quarts					
Glassware.					
Vases, glass	10	Oct. 1, 1902	$0.10	$1.00	H. Pinckney
Bowls, finger					
Plates, ice cream					
Glasses, sherry, stem					
Glasses, claret					
Bowls, champagne } Coat of arms					
Tumblers, champagne					
Glasses, Burgundy					
Goblets					
Plates, ice cream					
Decanters					
Saltcellars					
Bottles, water					
Dish, celery, flat					
Glasses, punch					
Dishes, berry, oblong					
Bowls, rose					
Bowl, rose					
Dishes, berry					
Dishes, olive, with handles					
Dishes, olive, without handles					
Dishes, olive					
Bottles, water					
Glasses, Sauterne, green					
Glasses, Sauterne, green					
Glasses, Burgundy, ruby					
Glasses, Burgundy, ruby					
Glasses, liqueur					
Goblets					
Bowls, finger					
Dishes, sauce					
Plates, ice cream					
Bowls, sugar					
Glasses, sherry					
Glasses, Rhine wine					
Glasses, claret					
Glasses, punch, tall, with handles					
Glasses, celery, tall					
Decanters, tall					
Stoppers, cut glass					
Glasses, Madeira, ruby					
Glasses, port					
Glasses, liqueur, engraved, roman border, old					
Glasses, sherry, engraved, roman border, old					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		10		10				June 30, 1903	10
		2		2				do	2
		1		1				do	1
		2		2				do	2
		3		3				do	3
		3		3				do	3
		1		1				do	1
		3		3				do	3
		3		3				do	3
		2		2				do	2
		6		6				do	6
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		24		24				do	24
		15		15				do	15
		4		4				do	4
		5		5				do	5
		11		11				do	11
		1		1				do	1
34	Oct. 23, 1902		10	10				June 30, 1903	10
		82		82				do	82
		70		70				do	70
		83		83				do	83
		94		94	10	Damaged and worthless.		do	84
		80		80				do	80
		70		70	5	Damaged and worthless.		do	65
		81		81	4	do		do	77
		97		97	6	do		do	91
		12		12				do	12
		7		7				do	7
		24		24				do	24
		26		26				do	26
		1		1				do	1
		89		89				do	89
		6		6				do	6
		2		2				do	2
		1		1				do	1
		6		6				do	6
		7		7				do	7
		2		2				do	2
		18		18				do	18
		40		40				do	40
		81		81				do	81
		12		12				do	12
		63		63				do	63
		24		24				do	24
		19		19				do	19
		9		9	9	Damaged and worthless.		do	0
		19		19				do	19
		47		47				do	47
		11		11				do	11
		2		2				do	2
		60		60	8	Damaged and worthless.		do	52
		7		7				do	7
		28		28				do	28
		25		25				do	25
		4		4				do	4
		17		17				do	17
		10		10				do	10
		54		54				do	54
		63		63				do	63
		19		19				do	19
		64		64				do	64

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Glassware—Continued.					
Glasses, champagne, engraved, roman border, old.	....	....	....	....	....
Glasses, sherry, engraved, with vine, odd	....	....	....	....	....
Glasses, liqueur, stem, engraved with vine, odd.	....	....	....	....	....
Glasses, sauterne, engraved with vine	....	....	....	....	....
Glasses, sauterne, engraved with vine	....	....	....	....	....
Glasses, sauterne, engraved with vine	....	....	....	....	....
Glasses, white wine, engraved with vine	....	....	....	....	....
Glasses, claret, engraved with vine	....	....	....	....	....
Glasses, claret, engraved with vine	....	....	....	....	....
Glasses, rhine wine, engraved with vine	....	....	....	....	....
Glasses, burgundy, engraved with vine	....	....	....	....	....
Glasses, claret, engraved with vine	....	....	....	....	....
Bowls, finger, engraved with vine	....	....	....	....	....
Bottles, water, engraved with vine	....	....	....	....	....
Dishes, berry, engraved with vine	....	....	....	....	....
Decanters, with handles, engraved with vine	....	....	....	....	....
Decanters, engraved with vine	....	....	....	....	....
Bottle, water, plain	....	....	....	....	....
Glasses, cocktail, engraved with star	....	....	....	....	....
Glasses, roman punch	....	....	....	....	....
Glasses, Maderia, engraved, roman border	....	....	....	....	....
Glasses, claret, engraved, roman border	....	....	....	....	....
Glasses, burgundy, engraved, roman border	....	....	....	....	....
Romers, engraved, vine border	....	....	....	....	....
Bowls, large, used with gilt plateau in state dining room.	....	....	....	....	....
Dishes, bonbon, iridescent	....	....	....	....	....
Goblets, plain	....	....	....	....	....
Stands, cake, high	....	....	....	....	....
Dishes, berry, high	....	....	....	....	....
Dishes, celery, engraved vine border	....	....	....	....	....
Decanters, with handles	....	....	....	....	....
Vases	....	....	....	....	....
Salt cellars, individual	....	....	....	....	....
Tumblers ....dozen	....	....	....	....	....
Chinaware.					
Teapots	2	Sept. 27, 1902	$0.35	$0.70	Dulin & Martin Co.
Toilet sets	2	Nov. 25, 1902	....	22.00	.....do
Cups ....dozen	2	Nov. 26, 1902	....	9.00	.....do
Saucers ....do	2	.....do	....	9.00	.....do
Ewers, china	....	....	....	....	....
Basins, china	....	....	....	....	....
Dishes, soap	....	....	....	....	....
Bowl	....	....	....	....	....
Mugs	....	....	....	....	....
Vases	....	....	....	....	....
Chambers, china	....	....	....	....	....
Jars, slop	....	....	....	....	....
Dish, butter	....	....	....	....	....
[Lincoln set.]					
Plates, soup	....	....	....	....	....
Plates, dinner	....	....	....	....	....
Plates, breakfast	....	....	....	....	....
Platters	....	....	....	....	....
Platters, fish (red border with eagle in center)	....	....	....	....	....
Plate, bread (red border with eagle in center)	....	....	....	....	....
Pitchers	....	....	....	....	....
Compotes	....	....	....	....	....
Stands, cake	....	....	....	....	....
Stands, pyramid	....	....	....	....	....
Stands, fruit	....	....	....	....	....
Bowls, punch	....	....	....	....	....

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		37	....	37	....			June 30, 1903	37
		16	....	16	....			do	16
		26	....	26	....			do	26
		13	....	13	....			do	13
		11	....	11	....			do	11
		18	....	18	....			do	18
		64	....	64	....			do	64
		29	....	29	....			do	29
		25	....	25	....			do	25
		4	....	4	....			do	4
		27	....	27	....			do	27
		17	....	17	....			do	17
		38	....	38	3	Damaged and worthless.		do	35
		23	....	23	....			do	23
		3	....	3	....			do	3
		6	....	6	....			do	6
		6	....	6	....			do	6
		1	....	1	....			do	1
		24	....	24	6	Damaged and worthless.		do	18
		20	....	20	....			do	20
		71	....	71	....			do	71
		14	....	14	....			do	14
		35	....	35	4	Damaged and worthless.		do	31
		20	....	20	....			do	20
		{20	....	20	....			do	20
		{2	....	2	....				2
		24	....	24	....			do	24
		78	....	78	78	Damaged and worthless.		do	0
		3	....	3	....			do	3
		3	....	3	....			do	3
		3	....	3	....			do	3
		3	....	3	....			do	3
		4	....	4	....			do	4
		11	....	11	....			do	11
		20	....	20	....			do	20
47	Dec. 24, 1902	....	2	2	....			June 30, 1903	2
47	do	1	2	3	....			do	3
47	do	....	2	2	....			do	2
47	do	....	2	2	....			do	2
		3	....	3	....			do	3
		2	....	2	....			do	2
		7	....	7	....			do	7
		1	....	1	....			do	1
		3	....	3	....			do	3
		2	....	2	....			do	2
		6	....	6	....			do	6
		2	....	2	....			do	2
		1	....	1	....			do	1
		6	....	6	....			June 30, 1903	6
		56	....	56	....			do	56
		37	....	37	....			do	37
		7	....	7	....			do	7
		6	....	6	....			do	6
		1	....	1	....			do	1
		4	....	4	....			do	4
		16	....	16	....			do	16
		12	....	12	....			do	12
		3	....	3	....			do	3
		9	....	9	....			do	9
		2	....	2	....			do	2

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
BASEMENT—continued.					
Chinaware—Continued.					
[Grant set.]					
Plates, soup (yellow border)					
Plates, dinner (flowers painted in center)					
Stands, cake					
Stands, fruit					
Compotes					
Plates, soup (plain, yellow band)					
Platters, meat					
Platters, fish					
Plates, soup					
Plates, soup, small, yellow, with flowers					
Plates, dinner, painted in center					
[Hayes set.]					
Plates, soup, decorated by Theo. Davis					
Plates, dinner, decorated by Theo. Davis					
Plates, oyster, decorated by Theo. Davis					
Plates, game, decorated by Theo. Davis					
Plates, fish, decorated					
Plates, cracker and cheese, decorated					
Plates, punch, decorated					
Plates, dessert, decorated					
Plates, salad, decorated					
Dishes, gravy boats, decorated					
Platter, fish					
Platters, game, ornamented with picture of canvasback duck.					
Platters, meat, turkey decorations					
Platters, ice-cream, ornamented with picture of snowshoe.					
Cups and saucers, coffee, odd shape					
Cups, coffee, after dinner					
[Arthur set.]					
Plates, dessert, odd					
Cups and saucers, Dresden, small					
Plate, dessert					
[Cleveland set.]					
Plates, dessert, turquoise					
Plates, dessert, ivory and gold					
Plates, dessert, odd					
Plates, dessert, scalloped edge blue					
Plates, dinner, blue border					
Plates, dinner, red and gold					
Plates, dinner, pink and gold border					
Plates, breakfast, green and gold					
Platter, ice-cream, pink and gold					
Plates, ice-cream, pink and gold					
Dishes, bonbon, flags of nations					
Plates, breakfast, rolled edge					
Cups, tea					
Saucers					
Cups, after-dinner					
Saucers, after-dinner					
Plates, Haviland, odd					
Plate, deep red, dinner					
Plates, rolled edge					
[Harrison set.]					
Plates, soup					
Plates, soup					
Plates, dinner					
Plates, breakfast					
Plates, bread and butter					
Cups, after-dinner					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		10		10				June 30, 1903	10
		3		3				do	3
		5		5				do	5
		5		5				do	5
		8		8				do	8
		20		20				do	20
		4		4				do	4
		1		1				do	1
		8		8				do	8
		13		13				do	13
		29		29				do	29
		25		25				June 30, 1903	25
		59		59				do	59
		48		48				do	48
		32		32				do	32
		6		6				do	6
		50		50				do	50
		36		36				do	36
		70		70				do	70
		7		7				do	7
		2		2				do	2
		1		1				do	1
		2		2				do	2
		2		2				do	2
		2		2				do	2
		8		8				do	8
		17		17				do	17
		23		23				June 30, 1903	23
		5		5				do	5
		1		1				do	1
		95		95				June 30, 1903	95
		18		18				do	18
		13		13				do	13
		11		11				do	11
		84		84				do	84
		84		84				do	84
		95		95				do	95
		96		96				do	96
		1		1				do	1
		3		3				do	3
		18		18				do	18
		393		393				do	393
		191		191				do	191
		190		190				do	190
		190		190				do	190
		193		193				do	193
		3		3				do	3
		1		1				do	1
		3		3				do	3
		8		8				June 30, 1903	8
		84		84				do	84
		80		80				do	80
		70		70				do	70
		55		55				do	55
		27		27	27	Damaged and worthless.		do	0

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Chinaware—Continued.					
[Harrison set—Continued.]					
Saucers, after-dinner	....	....	....	....	....
Plates, dinner	....	....	....	....	....
Plates, breakfast	....	....	....	....	....
Saucers, after-dinner	....	....	....	....	....
Cups, after-dinner	....	....	....	....	....
[McKinley set.]					
Plates, oyster	....	....	....	....	....
Plates, dessert, rose border	....	....	....	....	....
Plates, breakfast, green and gold border	....	....	....	....	....
Plates, breakfast, green and gold border	....	....	....	....	....
Plates, breakfast, blue and garland of roses	....	....	....	....	....
Plates, butter, individual	....	....	....	....	....
Cups, coffee, white and green	....	....	....	....	....
Saucers, coffee, white and green	....	....	....	....	....
Bowls, blue and white	....	....	....	....	....
Pitchers, blue and white	....	....	....	....	....
Plates, soup, deep red border	....	....	....	....	....
Pitcher, small, blue	....	....	....	....	....
Jar, cracker, Haviland	....	....	....	....	....
Ornament, china, hen on nest	....	....	....	....	....
Bowl, punch, high stand, blue and white	....	....	....	....	....
Ash receivers, shell, imitation	....	....	....	....	....
Ramakins, French, china	....	....	....	....	....
Cups, tea, odd, Haviland	....	....	....	....	....
Cups and saucers, coffee, green and gold border.	....	....	....	....	....
Cups and saucers, coffee, green and gold border.	....	....	....	....	....
Cups and saucers, large, colored bowl	....	....	....	....	....
Cups, tea, colored bowl	....	....	....	....	....
Cups, after-dinner coffee	....	....	....	....	....
Plate, tea, deep red border	....	....	....	....	....
Plate, breakfast, deep red border	....	....	....	....	....
Plate, dinner	....	....	....	....	....
Plates, soup, narrow yellow border	....	....	....	....	....
Plate, dinner, narrow yellow border	....	....	....	....	....
Plates, soup, wide red border	....	....	....	....	....
Cups, odd sizes	....	....	....	....	....
Saucers, odd sizes					
Plates, dinner ....dozen..	3	Feb. 20, 1903	$78.00	$234.00	The Van Heusen Charles Co.
Plates, breakfast ....do....	1	.....do......	....	78.00	.....do........
Plates, fish ....do....	1	.....do......	....	75.00	.....do........
Plates, tea ....do....	1	.....do......	....	69.75	.....do........
Plates, bread and butter ....do....	2	.....do......	61.50	123.00	.....do........
Plates, soup ....do....	4	.....do......	78.00	312.00	.....do........
Cups and saucers, after-dinner coffee ..do....	1	.....do......	....	117.00	.....do........
Cups and saucers, tea ....do....	3	.....do......	119.25	357.75	.....do........
Plates, oyster ....do....	1	.....do......	....	99.75	.....do........
Linen.					
Pillows	6	May 12, 1903	....	4.90	W. B. Moses & Sons.
Doilies ....dozens..	2	July 12, 1902	....	21.00	Porto Rican Benevolent Society.
Table cloth, 10½ yards long, embroidered "U. S."	....	....	....	....	....
Table cloths, 10½ yards long, embroidered "U. S."	....	....	....	....	....
Table cloth, 5 yards long, embroidered	....	....	....	....	....
Table cloth, 9 yards long	....	....	....	....	....
Table cloth, 6½ yards long	....	....	....	....	....
Table cloth, 5¼ yards long	....	....	....	....	....
Table cloth, 4 by 3 yards	....	....	....	....	....
Table cloth, 7 yards long	....	....	....	....	....

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		26		26	26	Damaged and worthless.		June 30, 1903	0
		15		15				do	15
		26		26				do	26
		29		29	29	Damaged and worthless.		do	0
		6		6	6	do		do	0
		24		24				do	24
		24		24				do	24
		12		12				do	12
		12		12				do	12
		12		12				do	12
		22		22				do	22
		5		5				do	5
		11		11				do	11
		6		6				do	6
		2		2				do	2
		9		9				do	9
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		6		6				do	6
		24		24				do	24
		14		14				do	14
		3		3				do	3
		12		12				do	12
		2		2				do	2
		5		5				do	5
		9		9				do	9
		1		1				do	1
		1		1				do	1
		1		1				do	1
		17		17				do	17
		1		1				do	1
		2		2	2	Damaged and worthless.		do	0
		18		18				do	18
		41		41				do	41
85	July 30, 1903		3	3				do	3
85	do		1	1				do	1
85	do		1	1				do	1
85	do		1	1				do	1
85	do		2	2				do	2
85	do		4	4				do	4
85	do		1	1				do	1
85	do		3	3				do	3
85	do		1	1				do	1
74	July 28, 1903		6	6				June 30, 1903	6
11	July 25, 1902		2	2				do	2
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		4		4	3	Worn-out and worthless.		do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
BASEMENT—continued.					
Linen—Continued.					
Table cloth, 4½ yards long					
Table cloth, 3 by 3					
Table cloth, 3 by 3, embroidered "U. S."					
Table cloth, 4 yards long					
Table cloth, 2½ yards long (servants')					
Table cloth, 1½ yards long (servants')					
Table cloth, 1¼ yards, cut down from long cloths.					
Covers, sideboard, hemstitched, embroidered "U. S.," old.					
Covers, sideboard, embroidered "U. S."					
Covers, sideboard, fringed					
Napkins					
Doilies, embroidered "U. S."					
Doilies, embroidered "U. S."					
Cloth, tray, hemstitched, emdroidered "U. S."					
Napkins, 28½ by 36 inches					
Napkins, large, embroidered "U. S."					
Napkins, large, embroidered "U. S." in red					
Napkins, breakfast, embroidered "U. S."					
Napkins, poppy pattern, embroidered "U. S."					
Napkins, fern pattern, embroidered "U. S."					
Napkins, fancy border, embroidered "U. S."					
Napkins, flower border, embroidered "U. S."					
Napkins, ribbon border, embroidered "U. S."					
Doilies, renaissance, open center					
Centerpiece, renaissance					
Doilies, large, German					
Doilies, medium, German					
Centerpieces					
Centerpiece, 1¼ yards square, renaissance					
Centerpiece, embroidered, scalloped edges					
Doilies, drawn work, small, square, embroidered in silk.					
Doilies, drawn work					
Doilies, square, hemstitched, embroidered in yellow silk.					
Doilies, scalloped edges, embroidered in silk.					
Doilies, large, plate, embroidered in colors					
Doilies, apliqué					
Towels, glass, red and blue border					
Towels, glass, red and blue border					
Towels, kitchen, crash					
Jackets, sweeping, white					
Jackets, sweeping, white duck					
Towels, roller, crash					
Aprons, gingham					
Aprons, denham					
Aprons, linen, white					
Felt, table ... pieces					
Crash, floor, linen ... lot					
Sheets, linen, double					
Sheets, linen, three-fourths					
Sheets, cotton, double					
Sheets, cotton, three-fourths					
Pillow slips, wide, linen					
Pillow slips, medium, linen					
Pillow slips, medium					
Bolster cases, linen					
Bedspreads, double					
Bedspreads, three-fourths					
Bath towels, fringed					
Bath towels, hemstitched					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		1		1				do	1
		10		10				do	10
		3		3				do	3
		10		10	2	Worn-out and worthless.		do	8
		7		7				do	7
		23		23				do	23
		26		26				do	26
		2		2				do	2
		7		7				do	7
		33		33	25	Worn-out and worthless.		do	8
		42		42	2	do		do	40
		30		30				do	30
		1		1				do	1
		52		52	20	Worn-out and worthless.		do	32
		57		57				do	57
		15		15				do	15
		40		40				do	40
		59		59	4	Worn-out and worthless.		do	55
		59		59				do	59
		12		12				do	12
		59		59				do	59
		177		177	9	Worn-out and worthless.		do	168
		17		17				do	17
		1		1				do	1
		12		12				do	12
		12		12				do	12
		2		2				do	2
		1		1				do	1
		2		2				do	2
		35		35	14	Worn-out and worthless.		do	21
		17		17				do	17
		10		10				do	10
		8		8				do	8
		12		12	12	Worn-out and worthless.		do	0
		10		10				do	10
		124		124	49	Worn-out and worthless.		do	75
		72		72	21	do		do	51
		32		32	32	do		do	0
		11		11				do	11
		12		12				do	12
		26		26				do	26
		23		23	3	Worn-out and worthless.		do	20
		14		14	2	do		do	12
		24		24	12	do		do	12
		9		9				do	9
		1		1	1	Worn-out and worthless.		do	0
		19		19				do	19
		48		48				do	48
		7		7				do	7
		51		51				do	51
		26		26				do	26
		45		45				do	45
		27		27				do	27
		11		11				do	11
		21		21				do	21
		7		7				do	7
		38		38				do	38
		24		24				do	24

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
BASEMENT—continued.					
Linen—Continued.					
Towels, blue border, embroidered "U. S."					
Towels, red border, embroidered "U. S."					
Towels, white, hemstitched					
Towels, blue border, embroidered "U. S."					
Towels, blue border, embroidered "U. S."					
Towels, pink border, embroidered "U. S."					
Towels, red border, embroidered "U. S."					
Towels, gold border, embroidered "U. S."					
Towels, crash, servants', embroidered "U. S."					
Towels, crash, servants'					
Towels, fringed, white, old					
Towels, fringed, blue, old					
Towels, fringed, red, old					
Cloths, wash					
Cloths, wash, hemstitched					
Cloths, wash, fringed					
Rugs, bath, dark-brown					
Doilies, Turkish					
Scarfs, bureau, hemstitched					
Scarfs, lined with blue					
Doilies, lace					
Covers, stand, edged with lace					
Curtains, sash, dotted Swiss					
Aprons, maids'					
Pillow shams, ruffled					
Pillow shams, lace ... pair					
Pillow shams, hemstitched and embroidered, pair					
Pillow shams, lace edge ... pair					
Pillow shams, sheet					
Cover, table, lace edge					
Cover, table, fringed					
Spreads, bed					
Blanket, bed					
Towels					
Blankets ... pair					
Storeroom.					
Hose, $\frac{3}{4}$ inch, 4-ply ... feet	400	June 1, 1903	$0.09½	$38.00	Rudolph, West & Co.
Ladders, hub, 8-foot	2	June 11, 1903		4.20	...do
Rat trap	1	May 27, 1903		.60	...do
Matting, white china ... lot					
Hamper, square, large					
Bed, rosewood					
Bed, walnut					
Bed, iron					
Screen, ebonized					
Ends for table used in State Dining Room ... lot					
Cooler, water, porcelain-lined					
Doors, baize, used at receptions					
Stands, music, iron, used by band					
Chairs, wooden, used by band					
Platform, wooden, used by leader of band					
Mat, cocoa					
Stove, self-feeding					
Stove, Belle No. 13					
Coal hods, galvanized-iron					
Baskets, wood					
Chair, barber's, walnut, upholstered					
Table sections used at state dinners					
Trusses for table used at State dinners					
Racks, skeleton, coat					
Boxes, coat ... lot					
Stands used in front of coat boxes ... do					
Tags, brass, used at receptions ... do					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		48		48				June 30, 1903	48
		109		109				do	109
		98		98				do	98
		60		60				do	60
		58		58				do	58
		48		48				do	48
		48		48				do	48
		48		48				do	48
		30		30				do	30
		72		72				do	72
		58		58				do	58
		9		9				do	9
		15		15				do	15
		26		26				do	26
		17		17				do	17
		13		13				do	13
		6		6				do	6
		46		46				do	46
		30		30				do	30
		4		4				do	4
		3		3				do	3
		15		15				do	15
		7		7				do	7
		2		2				do	2
		17		17				do	17
		1		1				do	1
		2		2				do	2
		1		1				do	1
		3		3				do	3
		1		1				do	1
		1		1				do	1
		40		40				do	40
		2		2				do	2
		3		3				do	3
		1		1				do	1
48	July 23, 1903		400	400				June 30, 1903	400
48	do		2	2				do	2
47	do		1	1				do	1
		1		1	1	Worn-out and worthless.		do	0
		1		1	1	Damaged and worthless.		do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		3		3				do	3
		48		48				do	48
		75		75				do	75
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		12		12	12	Damaged and worthless.		do	0
		7		7				do	7
		1		1				do	1
		12		12				do	12
		16		16				do	16
		6		6				do	6
		1		1	1	Sold at auction	By order of the President.	do	0
		1		1				do	1
		1		1				do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Storeroom—Continued.					
Table leaves, oak; belong to extension table.	....	....	......	......	....
Lamps used at receptions under canopies	....	....	......	......	....
Rods, iron, used for canopies ....lot	....	....	......	......	....
Hose, rubber ....feet	....	....	......	......	....
Wheelbarrow, iron, used in engine room	....	....	......	......	....
Pokers, long	....	....	......	......	....
Scrapers, long	....	....	......	......	....
Shovels, coal	....	....	......	......	....
Ax, short handle	....	....	......	......	....
Ax, long handle	....	....	......	......	....
Truck, with rubber-tired wheels	....	....	......	......	....
Fan, electric, 16-inch	....	....	......	......	....
Comforts, bed	....	....	......	......	....
Sweepers, carpet	....	....	......	......	....
Pails, swill	....	....	......	......	....
Pails, water	....	....	......	......	....
Scoop, sugar	....	....	......	......	....
Firepot	....	....	......	......	....
Brushes, hair	....	....	......	......	....
Combs	....	....	......	......	....
Pads, table, felt	....	....	......	......	....
Stencils, brass ....set	....	....	......	......	....
Chairs, folding ....dozen	....	....	......	......	....
Pans, dust	....	....	......	......	....
Hamper, clothes	....	....	......	......	....
Matting, cocoa ....yards	....	....	......	......	....
Coats, waiters'	....	....	......	......	....
Aprons, waiters'	....	....	......	......	....
Brushes, button	....	....	......	......	....
Kitchen.					
Shades, window	2	Dec. 10, 1902	$0.75	$1.50	A. E. Kennedy
Table, pine	1	....do	......	16.50	
Cups, fish ....dozen	2	Dec. 19, 1902	.90	1.80	Dulin & Martin Co.
Coffeepot, granite	1	Jan. 6, 1903	......	1.00	....do
Knife and fork, carving	1	....do	......	1.35	....do
Pots, granite	13	....do	......	10.60	....do
Broiler, meat	1	....do	......	.60	....do
Bowls, china	12	....do	......	1.56	....do
Pitchers, china	12	....do	......	3.48	....do
Cups, china	12	....do	......	3.42	....do
Plates, china	12	....do	......	2.59	....do
Broiler, oyster	1	....do	......	.35	....do
Strainer, soup	1	....do	......	2.00	....do
Opener, can	1	....do	......	.10	....do
Shaker, pepper	1	....do	......	.22	....do
Boiler, fish	1	....do	......	2.25	....do
Measure, quart	1	....do	......	.55	....do
Lemon squeezer	1	....do	......	.80	....do
Plates, pie, granite	3	....do	.18	.54	....do
Plates, pie, tin	3	....do	.06	.18	....do
Pans, bake, iron	6	....do	......	3.82	....do
Rollers, towel	2	....do	.18	.36	....do
Cooler, water, oak	1	....do	......	7.50	....do
Stand, cooler	1	....do	......	3.00	....do
Tumblers, glass ....dozen	2	Apr. 14, 1903	.65	1.30	....do
Coffeepot	1	....do	......	1.00	....do
Bowls, yellow ware	2	....do	.90	1.80	....do
Teapots	2	....do	.27	.54	....do
Colander	1	....do	......	.65	....do
Grater	1	....do	......	.27	....do
Knives, potato	6	Apr. 20, 1903	......	.63	....do
Basins, paper	2	....do	......	.50	....do
Tables, pine	....	....	......	......	....
Pans, sauce, copper	....	....	......	......	....
Kettle, stock, copper	....	....	......	......	....
Boilers, fish, copper	....	....	......	......	....
Boilers, ham, copper	....	....	......	......	....
Bowls, beating, copper	....	....	......	......	....

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and dat of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		8	....	8	4	Burned at place of storage.		June 30, 1903	4
		3	....	3	....			do	3
		1	....	1	....			do	1
		200	....	200	....			do	200
		1	....	1	....			do	1
		2	....	2	....			do	2
		2	....	2	....			do	2
		2	....	2	....			do	2
		1	....	1	....			do	1
		1	....	1	....			do	1
		1	....	1	....			do	1
		1	....	1	....			do	1
		3	....	3	....			do	3
		7	....	7	....			do	7
		6	....	6	....			do	6
		6	....	6	....			do	6
		1	....	1	....			do	1
		1	....	1	....			do	1
		3	....	3	....			do	3
		3	....	3	....			do	3
		3	....	3	....			do	3
		1	....	1	....			do	1
		6	....	6	....			do	6
		6	....	6	....			do	6
		1	....	1	....			do	1
		14	....	14	....			do	14
		12	....	12	....			do	12
		12	....	12	....			do	12
		6	....	6	....			do	6
9	Dec. 13, 1902	....	2	2	....			June 30, 1903	2
			1	1	....			do	1
60	Jan. 10, 1903	....	2	2	....			do	2
74	Feb. 28, 1903	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	13	13	....			do	13
74	do	....	1	1	....			do	1
74	do	....	12	12	....			do	12
74	do	....	12	12	....			do	12
74	do	....	12	12	....			do	12
74	do	....	12	12	....			do	12
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
74	do	....	3	3	....			do	3
74	do	....	3	3	....			do	3
74	do	....	6	6	....			do	6
74	do	....	2	2	....			do	2
74	do	....	1	1	....			do	1
74	do	....	1	1	....			do	1
56	May 29, 1903	....	2	2	....			do	2
56	do	1	1	2	....			do	2
56	do	....	2	2	....			do	2
56	do	....	2	2	....			do	2
56	do	....	1	1	....			do	1
56	do	....	1	1	....			do	1
56	do	....	6	6	....			do	6
56	do	....	2	2	....			do	2
		4	....	4	....			do	4
		26	....	26	2	Worn-out and worthless.		do	24
		1	....	1	....			do	1
		2	....	2	....			do	2
		1	....	1	....			do	1
		1	....	1	....			do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Kitchen—Continued.					
Brasiers, copper	....	....	......	....	....
Sugar melter, copper	....	....	......	....	....
Molds, fancy, large, jelly, copper	....	....	......	....	....
Molds, fancy, individual biscuit, copper	....	....	......	....	....
Molds, plain, copper	....	....	......	....	....
Pan, melting, copper, for sugar	....	....	......	....	....
Pans, sauce, block tin	....	....	......	....	....
Molds, tin, fancy	....	....	......	....	....
Molds, brick ice cream, tin	....	....	......	....	....
Molds, round, tin	....	....	......	....	....
Molds, melon, tin	....	....	......	....	....
Mortar, marble	....	....	......	....	....
Pestles for mortar	....	....	......	....	....
Rack, galvanized-iron	....	....	......	....	....
Whips, wire	....	....	......	....	....
Molds, lead, individual, ice cream	....	....	......	....	....
Strainers, Chinese	....	....	......	....	....
Forks, iron, long	....	....	......	....	....
Block, meat, round	....	....	......	....	....
Block, meat, sectional	....	....	......	....	....
Chopper, meat, "Enterprise"	....	....	......	....	....
Boards, meat, oak	....	....	......	....	....
Box, tin, square, for salt and pepper	....	....	......	....	....
Molds, tin, jelly	....	....	......	....	....
Cleavers	....	....	......	....	....
Saw, meat	....	....	......	....	....
Ladles, soups and sauces	....	....	......	....	....
Molds, tin, individual, small	....	....	......	....	....
Molds, tin, individual, medium	....	....	......	....	....
Cutters, vegetable	....	....	......	....	....
Cutters, cake, fancy	....	....	......	....	....
Pans, drip, tin	....	....	......	....	....
Molds, block tin, small	....	....	......	....	....
Molds, block tin, medium	....	....	......	....	....
Molds, block tin, pyramid	....	....	......	....	....
Formers, pastry, cup	....	....	......	....	....
Mold, tin, cone shaped	....	....	......	....	....
Molds, flat, pear shaped, small	....	....	......	....	....
Cutters, pastry	....	....	......	....	....
Chairs, wooden	....	....	......	....	....
Chair, arm, painted red	....	....	......	....	....
Freezers, ice-cream	....	....	......	....	....
Spoons, iron, long handle	....	....	......	....	....
Shaker, pepper	....	....	......	....	....
Egg beaters, "Dovers"	....	....	......	....	....
Paddles, wooden	....	....	......	....	....
Spoons, wooden	....	....	......	....	....
Cones, small	....	....	......	....	....
Coffee mill	....	....	......	....	....
Clock, 8-day, wooden	....	....	......	....	....
Pan, baking, patent double	....	....	......	....	....
Baskets, frying, iron	....	....	......	....	....
Pots, porcelain-lined	....	....	......	....	....
Pot, iron	....	....	......	....	....
Waffle iron	....	....	......	....	....
Molds, cake, tin, large, round	....	....	......	....	....
Pans, drip	....	....	......	....	....
Steamer	....	....	......	....	....
Steamer, patented	....	....	......	....	....
Kettle, tea, iron	....	....	......	....	....

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		2	....	2	....			June 30, 1903	2
		1	....	1	....			do	1
		9	....	9	....			do	9
		19	....	19	....			do	19
		4	....	4	....			do	4
		1	....	1	....			do	1
		7	....	7	7	Worn-out and worthless.		do	0
		4	....	4	....			do	4
		5	....	5	....			do	5
		8	....	8	....			do	8
		2	....	2	....			do	2
		1	....	1	....			do	1
		2	....	2	....			do	2
		1	....	1	....			do	1
		4	....	4	4	Worn-out and worthless.		do	0
		24	....	24	....			do	24
		3	....	3	3	Worn-out and worthless.		do	0
		3	....	3	3	do		do	0
		1	....	1	....			do	1
		1	....	1	1	Worn-out and worthless.		do	0
		1	....	1	....			do	1
		2	....	2	....			do	2
		1	....	1	1	Worn-out and worthless.		do	0
		4	....	4	4	do		do	0
		2	....	2	....			do	2
		1	....	1	....			do	1
		5	....	5	3	Worn-out and worthless.		do	2
		71	....	71	....			do	71
		16	....	16	....			do	16
		3	....	3	....			do	3
		6	....	6	....			do	6
		2	....	2	2	Worn-out and worthless.		do	0
		64	....	64	....			do	64
		14	....	14	....			do	14
		23	....	23	....			do	23
		2	....	2	....			do	2
		1	....	1	....			do	1
		28	....	28	....			do	28
		5	....	5	....			do	5
		6	....	6	6	Damaged and worthless.		do	0
		1	....	1	....			do	1
		3	....	3	2	Worn-out and worthless.		do	1
		3	....	3	....			do	3
		1	....	1	....			do	1
		2	....	2	....			do	2
		6	....	6	6	Worn out and worthless.		do	0
		8	....	8	8	do		do	0
		22	....	22	22	do		do	0
		2	....	2	1	do		do	1
		1	....	1	....			do	1
		1	....	1	....			do	1
		3	....	3	....			do	3
		2	....	2	1	Worn out and worthless.		do	1
		1	....	1	1	Damaged and worthless.		do	0
		1	....	1	....			do	1
		3	....	3	....			do	3
		18	....	18	....			do	18
		1	....	1	....			do	1
		1	....	1	....			do	1
		1	....	1	....			do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Kitchen—Continued.					
Colanders, tin					
Pan, bread					
Boiler, double agate ware					
Crocks					
Brush, wire					
Dredgers, tin					
Pick, ice					
Bowls, yellow					
Bowls, white					
Pans, dish, tin					
Pans, frying					
Broilers, wire					
Plates, pie					
Pans, muffin, Russian wire					
Pans, bread, Russian wire					
Pans, roll, Russian wire					
Cake tins, jelly					
Grater, nutmeg					
Strainers, wire					
Strainers, Chinese					
Knife, chopping					
Bowl, chopping, wooden					
Strainers, gravy, tin					
Measure, quart, graduated					
Box, knife, walnut					
Funnel, tin					
Grater, bread, tin					
Cans, garbage, galvanized iron, large					
Cans, garbage, galvanized iron, small					
Pan, bain Marie, to use on range					
Servers, puree, tin frame					
Tureen, soup, yellow ware					
Cups, hotel china, white					
Saucers, hotel china, white					
Pitchers, milk					
Pitchers, water					
Dishes, baking, French					
Dishes, vegetable, hotel china					
Platters, hotel china					
Plates, soup, hotel china					
Plates, breakfast, hotel china					
Knives, sabatier					
Knives, hotel carvers					
Forks, hotel					
Knife, palette, long					
Knife, sabatier, scallop					
Openers, can, 1 nickel and 1 iron					
Corkscrew, wooden handle					
Scoop, potato					
Steel					
Coffeepot, 4-quart, tin					
Dishes, meat					
Bottle, radish					
Lemon squeezer, aluminum					
Saucepans, assorted .....dozen					
Boilers, double					
Pans, jelly					
Spoons, iron, assorted					
Teakettle					
Plates, pie					

Executive Mansion June 30, 1903—Continued.

Voucher— No.	Voucher— Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
		3		3				June 30, 1903	3
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1	1	Worn-out and worthless.		do	0
		3		3				do	3
		1		1	1	Damaged and worthless.		do	0
		12		12	12	do		do	0
		9		9				do	9
		2		2				do	2
		23		23				do	23
		5		5				do	5
		12		12	4	Worn-out and worthless.		do	8
		3		3	1	do		do	2
		8		8				do	8
		8		8	3	Worn-out and worthless.		do	5
		6		6	6	do		do	0
		1		1				do	1
		2		2	2	Worn-out and worthless.		do	0
		3		3	3	do		do	0
		1		1				do	1
		1		1	1	Worn-out and worthless.		do	0
		3		3				do	3
		1		1				do	1
		1		1				do	1
		4		4				do	4
		1		1				do	1
		2		2	2	Damaged and worthless.		do	0
		2		2				do	2
		1		1				do	1
		3		3	3	Damaged and worthless.		do	0
		1		1				do	1
		9		9	9	Damaged and worthless.		do	0
		9		9	9	do		do	0
		3		3	3	do		do	0
		1		1	1	do		do	0
		4		4	4	do		do	0
		6		6				do	6
		6		6				do	6
		3		3	3	Damaged and worthless.		do	0
		4		4	4	do		do	0
		3		3	3	do		do	0
		3		3	3	do		do	0
		2		2	2	do		do	0
		1		1				do	1
		1		1				do	1
		2		2	1	Damaged and worthless.		do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Worn-out and worthless.		do	0
		6		6				do	6
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		8		8				do	8
		6		6				do	6
		1		1				do	1
		6		6				do	6

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Kitchen—Continued.					
Broilers					
Griddle					
Washer, lettuce					
Waffle iron					
Bowls					
Pans, baking					
Muffin rings					
Spoons, table					
Measure, tin					
Shaker, salt					
Measures, tin					
Knife, carving					
Coffeepot					
Biggin, coffee					
Teapot					
Tea caddy					
Pot, stock					
Knife					
Fork					
Bowl, chop					
Bread raiser					
Strainer					
Beater, egg					
Turners, cake					
Egg beater					
Cover, apple					
Dishes, bake					
Pans, dish					
Shears, sardine ... pair					
Knife, chop					
Can, tin, for flour					
Pitchers					
Grater					
Strainer					
Brush for cleaning silver					
Chopper, meat					
Boilers, double					
Mold					
Jar for tea					
Pans					
Kettles					
Cutters, tin ... set					
Steamer					
Cutter, meat					
Colanders					
Pans, dish					
Pans, bread					
Knives					
Chairs					
Masher, potato					
Sieve					
Dishes, butter					
Billiard room.					
Carpet, Wilton, red					
Shades, white, Holland					
Rack, hat, walnut					
Chair, invalid's					
Cushions for invalid's chair					
Chairs, walnut, perforated seats					
Counters, string ... set					
Cuspidor, china					
Chair, arm, walnut, upholstered in leather					
Rack, walnut, for pool balls					
Table, billiard, Brunswick-Balke Co. combination.					
Balls ... set					
Balls, straight billiard ... sets					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
....	....	5	....	5	....	....	....	June 30, 1903	5
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	12	....	12	....	....	....	.....do	12
....	....	7	....	7	....	....	....	.....do	7
....	....	18	....	18	....	....	....	.....do	18
....	....	12	....	12	....	....	....	.....do	12
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	1	....	1	....	....	....	.....do	1
....	....	4	....	4	....	....	....	.....do	4
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	3	....	3	....	....	....	.....do	3
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	2	....	2	....	....	....	.....do	2
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	6	....	6	....	....	....	.....do	6
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	3	....	3	....	....	....	.....do	3
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	2	....	2	....	....	....	.....do	2
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	6	....	6	....	....	....	.....do	6
....	....	12	....	12	....	....	....	.....do	12
....	....	9	....	9	....	....	....	.....do	9
....	....	9	....	9	....	....	....	.....do	9
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	2	....	2	....	....	....	.....do	2
....	....	1	....	1	....	....	....	June 30, 1903	1
....	....	2	....	2	2	Worn-out and worthless.	....	.....do	0
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	1	Sold at auction....	By order of the President.	.....do	0
....	....	2	....	2	2	Worn-out and damaged.	....	.....do	0
....	....	3	....	3	....	....	....	.....do	3
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	....	....	....	.....do	1
....	....	1	....	1	1	Sold at auction....	By order of the President.	.....do	0
....	....	1	....	1	1	.....do	.....do	.....do	0
....	....	3	....	3	3	.....do	.....do	.....do	0

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
BASEMENT—continued.					
Billiard room—Continued.					
Rack					
Cues					
Mace					
Bridges					
Stand, wash, walnut					
Bowl and pitcher, white china					
Brush for cleaning table					
Bottle, leather					
Bottles, leather					
Fender, brass					
Rules, framed ... set					
Engine room.					
Emery wheel, 4-inch					
Coal hods, galvanized iron					
Shovels, fire, galvanized					
Baskets, wood					
Gentlemen's dressing room.					
Carpet, Wilton ... yards					
Mirror, over mantel					
Diplomatic assembly reception room.					
Carpet, Wilton ... yards					
Sofas, with backs and arms, gilded wood frames, upholstered in blue damask.					
Chairs, arm, same as above					
Chairs, without arms, same as above					
Do					
Divan, circular, gilded wood frame, 6 legs, etc.					
Basement corridor.					
Drapery, satin damask, red ... pairs					
Settees, reupholstered in satin damask					
Carpet, Wilton, red ... yards					
Settees, oak frames, upholstered in red					
Chairs, arm, oak frames upholstered in red					
WEST TERRACE.					
Servants' dining room.					
Table, dining, plain					
Chair, youth's					
Screen, Japanese					
Tablecloths					
Napkins					
Bowls, oatmeal					
Plates					
Plates, soup					
Cups, egg					
Bowls, sugar					
Cups					
Saucers					
Pitchers					
Knives					
Spoons, tea					
Forks					
Tumblers					
Cruets, salt					
Cruets, pepper					
Chairs					
Cruets, glass					
Teapots					
Mats, table					
Sewing machine, Domestic					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
....	....	1	....	1	....	....	....	June 30, 1903	1
....	....	13	....	13	11	Sold at auction....	By order of the President.	.....do.......	2
....	....	1	....	1	....	....	....	.....do.......	1
....	....	2	....	2	....	....	....	.....do.......	2
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	2	....	2	....	....	....	.....do.......	2
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	June 30, 1903	1
....	....	12	....	12	....	....	....	.....do.......	12
....	....	6	....	6	....	....	....	.....do.......	6
....	....	6	....	6	....	....	....	.....do.......	6
....	....	141⅓	....	141⅓	....	....	....	June 30, 1903	141⅓
....	....	1	....	1	....	....	....	.....do.......	1
....	....	115⅓	....	115⅓	....	....	....	June 30, 1903	115⅓
....	....	4	....	4	....	....	....	.....do.......	4
....	....	4	....	4	....	....	....	.....do.......	4
....	....	4	....	4	....	....	....	.....do.......	4
....	....	4	....	4	....	....	....	.....do.......	4
....	....	1	....	1	....	....	....	.....do.......	1
....	....	2	....	2	....	....	....	June 30, 1903	2
....	....	4	....	4	....	....	....	.....do.......	4
....	....	365⅓	....	365⅓	....	....	....	.....do.......	365⅓
....	....	4	....	4	....	....	....	.....do.......	4
....	....	2	....	2	....	....	....	.....do.......	2
....	....	1	....	1	....	....	....	June 30, 1903	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	10	....	10	....	....	....	.....do.......	10
....	....	36	....	36	....	....	....	.....do.......	36
....	....	12	....	12	....	....	....	.....do.......	12
....	....	24	....	24	....	....	....	.....do.......	24
....	....	12	....	12	....	....	....	.....do.......	12
....	....	12	....	12	....	....	....	.....do.......	12
....	....	2	....	2	....	....	....	.....do.......	2
....	....	24	....	24	....	....	....	.....do.......	24
....	....	24	....	24	....	....	....	.....do.......	24
....	....	4	....	4	....	....	....	.....do.......	4
....	....	12	....	12	....	....	....	.....do.......	12
....	....	24	....	24	....	....	....	.....do.......	24
....	....	12	....	12	....	....	....	.....do.......	12
....	....	24	....	24	....	....	....	.....do.......	24
....	....	2	....	2	....	....	....	.....do.......	2
....	....	2	....	2	....	....	....	.....do.......	2
....	....	9	....	9	....	....	....	.....do.......	9
....	....	2	....	2	....	....	....	.....do.......	2
....	....	2	....	2	....	....	....	.....do.......	2
....	....	24	....	24	....	....	....	.....do.......	24
....	....	1	....	1	....	....	....	.....do.......	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
WEST TERRACE—continued.					
Servants' rooms.					
Carpet, Wilton ... yards					
Matting, white China ... do					
Bed, iron					
Mattresses, hair	2	Dec. 3, 1902	$29.20	$58.40	A. E. Kennedy
Spring, woven wire					
Pillows, feather					
Bed, folding, walnut					
Mattress					
Chair, arm, upholstered					
Rocker, wicker					
Chair, arm, high back, painted red					
Rocker, cherry					
Table, pine					
Bureau, ash					
Washstand, ash					
Stand, typewriter, walnut					
Comforters					
Toilet set					
Sideboard, oak					
Desk, oak					
Chairs, wicker					
Mirror, oak frame					
Stand, shaving, mahogany					
Chair, arm, high back, painted red					
Shade, white, Holland					
Bed, small, iron					
Mattress, husk, cotton top					
Pillow, feather					
Dresser, rosewood					
Wardrobe, walnut					
Chairs, splan seat					
Washstand, mahogany					
Toilet set, 4 pieces					
Curtains, cotton damask					
Bedstead, enamel and brass, with spring					
Mattress, cotton					
Comfort, bed					
Shades, made from old shades					
Matting, white, China ... yards					
Shades, white, Holland					
Laundry.					
Irons, polishing	4	Jan. 2, 1903	.90	3.60	Dulin & Martin Co.
Baskets	2	Feb. 6, 1903	2.50	5.00	do
Irons, sad	12	Feb. 19, 1903		3.60	do
Cooler, water	1	Feb. 27, 1903		4.75	do
Stoves, gas, 2-burner, with 8 sad-iron heaters	4	Feb. 9, 1903		14.50	W. S. Jenks
Stove, gas, 2-burner, with 2 sad-iron heaters	1	Apr. 13, 1903		4.50	do
Irons, sad	6	Apr. 8, 1903		.68	Dulin & Martin Co.
Stove, heating irons					
Tables, pine, large					
Irons, flat, 6 and 7 pound					
Board, ironing					
Board, bosom					
Carpet, Wilton ... yards					
Mirror, in gilt frame					
Wringer, for clothes					
Wardrobe, maple					
Brush, fringe					
Washboards					
Truck, flat, with rubber-tired wheels					
Stands for flatirons					

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		65		65				June 30, 1903	65
		58		58	24	Worn-out and worthless.		do	34
		1		1				do	1
7	Dec. 6, 1902	1	2	3				do	3
		1		1				do	1
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		3		3				do	3
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1	1	Worn-out and worthless.		do	0
		1		1				do	1
		1		1	1	Worn-out and worthless.		do	0
		1		1	1	Burned at place of storage.		do	0
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1	1	Damaged and worthless.		do	0
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		7		7				do	7
		245		245				do	245
		3		3				do	3
74	Feb. 28, 1903		4	4				June 30, 1903	4
49	Mar. 23, 1903		2	2				do	2
49	do		12	12				do	12
49	do		1	1				do	1
36	May 29, 1903		4	4				do	4
36	do		1	1				do	1
56	do	8	6	14				do	14
		1		1	1	Worn-out and worthless.		do	0
		4		4				do	4
		14		14				do	14
		1		1				do	1
		1		1				do	1
		24		24	24	Worn-out and worthless.		do	0
		1		1	1	Sold at auction		do	0
		1		1				do	1
		1		1				do	1
		1		1				do	1
		12		12				do	12
		1		1				do	1
		3		3				do	3

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
EAST TERRACE.					
Matting, cocoa ....yards..	113	Feb. 20, 1903	$0.75	$84.75	A. E. Kennedy..
POLICEMEN'S LOBBY.					
Stand, water cooler....	1	Apr. 25, 1903	....	3.00	Dulin & Martin Co.
MISCELLANEOUS LIST.					
Mat, lamp, plush	1	Nov. 26, 1902	....	1.30	A. E. Kennedy..
Sewing machine, Singer....	1	Nov. 28, 1902	....	40.00	The Singer Manufacturing Co.
Trays	6	Nov. 25, 1902	....	3.00	Dulin & Martin Co.
Pitchers and trays, plated	3	Nov. 26, 1902	....	46.00	.....do ....
Rope barriers, plush	3	Jan. 2, 1903	6.40	19.20	A. E. Kennedy..
Flag, storm	1	Dec. 27, 1902	....	2.09	Quartermaster, U. S. Army.
Carpet, Wilton ....yards..	232	Jan. 2, 1903	2.50	580.00	A. E. Kennedy..
Pique ....do....	56	Jan. 9, 1903	.40	22.40	.....do ....
Vases	18	Dec. 1, 1902	....	15.25	Dulin & Martin Co.
Table, pine, 6-foot	1	Dec. 4, 1902	....	7.00	W. B. Moses & Sons.
Bed	1	Dec. 10, 1902	....	8.00	.....do ....
Mattress, hair and cotton....	1	.....do	....	4.00	.....do ....
Bed	1	.....do	....	8.00	.....do ....
Mattress, hair and cotton....	1	.....do	....	3.50	.....do ....
Beds, white enamel	4	.....do	8.00	32.00	.....do ....
Mattresses, hair and cotton....	4	.....do	3.50	14.00	.....do ....
Chairs, spline seat	6	Dec. 13, 1902	.65	3.90	.....do ....
Shade, lamp	1	Nov. 12, 1903	....	4.90	Geo. F. Muth & Co.
Stove, gas, 2-burner	1	Jan. 26, 1903	....	3.00	The E. F. Brooks Co.
Bureau sets	2	Jan. 6, 1903	....	2.10	Dulin & Martin Co.
Baskets, for wood....	6	.....do	3.00	18.00	.....do ....
Rack, bicycle....	1	Mar. 14, 1903	....	4.90	A. E. Kennedy..
Cabinet....	1	Feb. 28, 1903	....	45.00	Old Colony Co..
Desk....	1	.....do	....	25.00	.....do ....
Shade, lamp, cut	1	Feb. 2, 1903	....	22.00	Dulin & Martin Co.
Vases	36	Feb. 9, 1903	....	16.95	.....do ....
Lamp, silver....	1	Apr. 27, 1903	....	25.00	Galt & Bro ....
Chairs, wooden....dozen..	4	May 14, 1903	9.00	36.00	A. E. Kennedy..
Chairs, wooden ....do....	2	June 1, 1903	9.00	18.00	.....do ....
Covers, furniture, cotton damask....	271	Apr. 11–June 30, 1903.	3.55	962.05	.....do ....
Stands, music....	5	June 27, 1903	1.75	8.75	Carl Fisher New York.
Table, pine, used in State Dining Room, covered with green baize.	....	....	....	....	....
Scale, platform, Fairbanks No. 11	....	....	....	....	....
Extinguisher, fire, Babcock's....	....	....	....	....	....
Box, ice, "Ridgeway," oak....	....	....	....	....	....
Hose, air, black rubber ....feet..	....	....	....	....	....
Stand, mahogany, marble top	....	....	....	....	....
Boxes, hat ....lot..	....	....	....	....	....
Carpet, Wilton, red	....	....	....	....	....
Stove....	....	....	....	....	....
Metal board, enameled, to go under stove....	....	....	....	....	....
Desk, walnut	....	....	....	....	....
Pail, galvanized iron	....	....	....	....	....
Chairs, splan seats	....	....	....	....	....
Carpet, Wilton ....yards..	....	....	....	....	....
PRESIDENT'S STABLE.					
Carpet, Wilton....	....	....	....	....	....
Stove, small, and pipe	....	....	....	....	....
Boiler, tin, for heating water	....	....	....	....	....
Chairs, wooden	....	....	....	....	....

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
67	Feb. 28, 1903	....	113	113	....	....	....	June 30, 1903	113
47	Apr. 25, 1903	....	1	1	....	....	....	June 30, 1903	1
65	Nov. 29, 1902	....	1	1	....	....	....	June 30, 1903	1
9	Dec. 24, 1902	....	1	1	....	....	....	.....do.......	1
47	.....do.......	....	6	6	....	....	....	.....do.......	6
47	.....do.......	....	3	3	....	....	....	.....do.......	3
9	Jan. 3, 1903	....	3	3	....	....	....	.....do.......	3
14	Jan. 6, 1903	....	1	1	....	....	....	.....do.......	1
21	Jan. 10, 1903	....	232	232	....	....	....	.....do.......	232
21	.....do.......	....	56	56	....	....	....	.....do.......	56
60	Jan. 26, 1903	....	18	18	....	....	....	.....do.......	18
65	.....do.......	....	1	1	....	....	....	.....do.......	1
65	.....do.......	....	1	1	....	....	....	.....do.......	1
65	.....do.......	....	1	1	....	....	....	.....do.......	1
65	.....do.......	....	1	1	....	....	....	.....do.......	1
65	.....do.......	....	1	1	....	....	....	.....do.......	1
65	.....do.......	....	4	4	....	....	....	.....do.......	4
65	.....do.......	....	4	4	....	....	....	.....do.......	4
65	.....do.......	....	6	6	....	....	....	.....do.......	6
81	Jan. 28, 1903	....	1	1	....	....	....	.....do.......	1
69	.....do.......	....	1	1	....	....	....	.....do.......	1
74	Feb. 28, 1903	....	2	2	....	....	....	.....do.......	2
74	.....do.......	....	6	6	....	....	....	.....do.......	6
12	Mar. 14, 1903	....	1	1	....	....	....	.....do.......	1
27	Mar. 20, 1903	....	1	1	....	....	....	.....do.......	1
27	.....do.......	....	1	1	....	....	....	.....do.......	1
49	Mar. 23, 1903	....	1	1	....	....	....	.....do.......	1
49	.....do.......	....	36	36	....	....	....	.....do.......	36
70	Apr. 27, 1903	....	1	1	....	....	....	.....do.......	1
36	June 6, 1903	....	4	4	....	....	....	.....do.......	4
48	June 13, 1903	....	2	2	....	....	....	.....do.......	2
....	....	....	271	271	....	....	....	.....do.......	271
76	July 28, 1903	....	5	5	....	....	....	.....do.......	5
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	200	....	200	....	....	....	.....do.......	200
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	4	....	4	....	....	....	.....do.......	4
....	....	$41\frac{1}{3}$	....	$41\frac{1}{3}$	....	....	....	.....do.......	$41\frac{1}{3}$
....	....	1	....	1	....	....	....	June 30, 1903	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	1	....	1	....	....	....	.....do.......	1
....	....	2	....	2	....	....	....	.....do.......	2

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
PRESIDENT'S STABLE—continued.					
Washstand, walnut, marble top	....				
Hose, rubber, ¾ ... feet..	....				
Chamois skins	1	Sept. 22, 1902		$0.65	Lutz & Co
Brush, horse	....				
Brush, mane	1	Sept. 22, 1902		.65	Lutz & Co
Duster, feather	....				
Robe, lap	....				
Brushes, dandruff	....				
Stove, No. 40 "Comet," with pipe	....				
Sieve, ash	....				
Boots, rubber ... pair..	....				
Towels, horse	....				
Hose, rubber, 1-inch 3-ply ... feet..	....				
Crock	....				
Hods, coal	....				
Shades, window	....				
Brushes, wall	3	July 30, 1902		2.88	Rudolph, West & Co.
Reins, russet leather	16	Aug. 13, 1902	$0.85	13.60	Lutz & Co
Comb, curry	1	Sept. 22, 1902		.35	....do
Scraper, sweat	1	....do		.75	....do
Screens, fly, wooden frames	....				
STABLE OF PUBLIC BUILDINGS AND GROUNDS.					
Mare, bay	....				
Wagon, Dayton, with top and 2 seats	....				
Harness, single ... set..	....				
Harness, single, Concord ... do..	....				
Blanket, woolen, for street use	....				
Blanket, stable	....				
Blanket, rubber	....				
Robes, light weight, for wagon	....				
Robe, fur	....				
IN STORAGE FOR FUTURE USE.					
Desk, walnut, carved ornaments	....				
Settee, mahogany, upholstered in leather	....				
Mirror, in gilt frame, formerly in Blue Parlor	....				
Mirrors, in drab-colored frame	....				
Sofas, in frame; 1 upholstered	....				
Carpets	....				
FIRST FLOOR.					
East Room.					
Crash to cover floor ... lot..	1	1902–3		315.60	L. Marcotte & Co., New York.
Candelabra on mantels, 9 lights each, with marble vases, real candles, glass bobeches, dark fire gilt ... pairs..	4	1902–3	585.00	2,340.00	....do
Electric standards, 12 lights, dark fire gilt, marble bases, candelabra lamps.	4	1902–3	900.00	3,600.00	....do
Curtains for windows, made of damask, old-gold color, lined with silk, interlined with molleton, front and bottom finished with fringe, silk-center tassels, silk tassel loops ... sets..	7	1902–3		4,212.39	....do
Window cornices, carved cherry wood and partly papier-maché, gilded ... sets..	7	1902–3		422.40	....do
Banquettes, 11, 4 feet 6 inches by 1 foot 6 inches; 2, 2 feet 9 inches by 1 foot 6 inches; richly carved, gilded, and glazed to an old effect, stuffed plain, covered with bouton d'or, colored velours de genes, finished with gimp loose covers of yellow figured linen.	13	1902–3		2,651.96	....do
Consol tables, Louis XVI, gilded, marble tops.	4	Apr. 29, 1903	309.65	1,238.60	....do
Andirons, Louis XVI, in gilt ... pairs..	4				
Dogs, iron ... sets..	2				
Fire tools, iron (poker and shovel to each), sets	4	Mar. 7, 1903		1,624.00	....do
Stands, gilt, for fire tools	4				

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
		1		1				June 30, 1903	1
		20		20				do	20
30	Oct. 23, 1902	5	1	6				do	6
		1		1				do	1
30	Oct. 23, 1902	2	1	3				do	3
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				do	1
		1		1				do	1
		6		6				do	6
		100		100				do	100
		1		1				do	1
		2		2				do	2
		4		4				do	4
28	Aug. 23, 1902		3	3				do	3
29	Sept. 23, 1902		16	16				do	16
30	Oct. 23, 1902		1	1				do	1
30	do		1	1				do	1
		2		2				do	2
		1		1				June 30, 1903	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		1		1				do	1
		2		2				do	2
		1		1				do	1
		1		1				June 30, 1903	1
		1		1				do	1
		1		1	1	Sold at auction	By order of the President.	do	0
		2		2	2	Burned at place of storage.		do	0
		2		2				do	2
		3		3	3	Burned at place of storage.		do	0
18	Feb. —, 1903		1	1				June 30, 1903	1
73 16	Dec. —, 1902 Mar. —, 1903		4	4				do	4
72 17	do do		4	4				do	4
22 15 18 & 19	Nov. —, 1902 Dec. —, 1902 Jan. —, 1903		7	7				do	7
22 15 18 & 19	Nov. —, 1902 Dec. —, 1902 Jan. —, 1903		7	7				do	7
22 15 18 & 19	Nov. —, 1902 Dec. —, 1902 Jan. —, 1903		13	13				do	13
15	May —, 1903		4	4				do	4
			4	4				do	4
			2	2				do	2
16	May —, 1903		4	4				do	4
			4	4				do	4

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Green Parlor.					
Curtain poles	2	1902-3	$40.92	$81.85	L. Marcotte & Co., New York.
Curtains for windows, with drapery decorations, pairs.	2	1902-3	355.00	710.00	Herter Bros., New York.
Sofa, Pillows: white, painted, in cotton	1, 2	1902-3	....	185.00	A. H. Davenport, Boston.
Armchairs, in cotton, painted	4	1902-3	85.00	340.00	.....do
Side chairs	4	1902-3	42.00	168.00	.....do
Light chairs, cane seats	6	1902-3	38.00	228.00	.....do
Chairs, in silk, gilded	6	1902-3	105.00	630.00	.....do
Rug, India	1	Feb. 27, 1903	....	389.23	L. Marcotte & Co., New York.
Screen, brass, folding	1	Mar. 7, 1903	....	28.00	.....do
Blue Parlor.					
Hangings, windows, curtains and draperies, blue silk reps to match walls; curtains finished front and bottom with embroidery; draperies with embroidered stars and border, lined with silk, interlined with molleton, finished with silk bullion fringe, silk tassel loops, silk center tassels.	3	1902-3	....	2,570.48	L. Marcotte & Co., 298 Fifth ave., New York.
Window poles for curtains, richly carved wood, with carved eagle, gilded and glazed.	3	1902-3	....	397.98	.....do
Ventilators, Pullman, for windows	2	1902-3	....	35.00	Pullman Autom. Ventil. Co., York, Pa.
Stanchions, bronze, for roping off space	2	1902-3	....	77.50	Jno. Williams, New York.
Stanchion, bronze, for roping off space	1	1902-3	....	40.00	.....do
Sofa, Armchairs, Single chairs, Small chairs, Footstools: Richly carved, white and gold, covered with brocade, trimmed with gimp, finished as above.	1, 4, 4, 6, 4	1902-3	....	3,697.91	L. Marcotte & Co., New York.
Cordon to cut off the room, covered with gold silk velours.	1	1902-3	....	36.46	.....do
Screens, white silk	40	Mar. 2, 1903	2.00	80.00	Edw. F. Caldwell & Co., New York.
Shades, white silk	15	.....do	2.50	37.50	.....do
Screen, brass, folding, for fireplace	1	Mar. —, 1903	....	30.00	L. Marcotte & Co., New York.
Red Parlor.					
Curtain poles	2	1902-3	40.92	81.85	L. Marcotte & Co., New York.
Rug, Kinnan, 14 feet 8 inches by 19 feet	1	1902-3	....	1,250.00	Van Gaasbeek & Arkell, New York.
Curtains for windows, with drapery decorations, pair.	2	1902-3	450.00	900.00	Herter Bros., New York.
Sofas, stuffed all over, red silk	2	1902-3	201.89	403.78	L. Marcotte & Co., New York.
Armchairs, stuffed all over, red silk	2	1902-3	82.90	165.80	.....do
Pillows, feather, covered with red-silk damask, trimmed with fringe, gimp, and rosettes.	4	1902-3	13.42	53.67	.....do
Armchairs, stuffed all over, wooden rim, model Henry II, covered with red velours ornamented with fringe, gimp, and effilé.	2	1902-3	74.19	148.58	.....do
Footstools, pillow shaped, covered plain with red velours, ornamented with cord.	4	1902-3	13.91	55.65	.....do
Small chairs, richly carved, white and gold, covered with brocade, trimmed with gimp.	6	1902-3	....	....	.....do
Andirons, gilt .... pair	1	Mar. 7, 1893	....	135.00	.....do
Screen, brass	1	.....do	....	28.00	.....do

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
20	Jan. —, 1903	....	2	2	....	....	....	June 30, 1903	2
....	....	....	2	2	....	....	....	.....do	2
102	Jan. —, 1903	....	1	1	....	....	....	.....do	1
102	.....do	....	2	2	....	....	....	.....do	2
102	.....do	....	4	4	....	....	....	.....do	4
102	.....do	....	4	4	....	....	....	.....do	4
102	.....do	....	6	6	....	....	....	.....do	6
102	.....do	....	6	6	....	....	....	.....do	6
15	Mar. —, 1903	....	1	1	....	....	....	.....do	1
16	May —, 1903	....	1	1	....	....	....	.....do	1
45	Jan. —, 1903	....	3	3	....	....	....	June 30, 1903	3
45	.....do	....	3	3	....	....	....	.....do	3
75	.....do	....	2	2	....	....	....	.....do	2
40	.....do	....	2	2	....	....	....	.....do	2
29	Feb. —, 1903	....	1	1	....	....	....	.....do	1
22	Nov. —, 1902	....	1	1	....	....	....	.....do	1
15	Dec. —, 1902	....	4	4	....	....	....	.....do	4
18	Jan. —, 1903	....	4	4	....	....	....	.....do	4
19	.....do	....	6	6	....	....	....	.....do	6
			4	4	....	....	....	.....do	4
Same as above		....	1	1	....	....	....	.....do	1
35	Mar. —, 1903	....	40	40	....	....	....	.....do	40
35	.....do	....	15	15	....	....	....	.....do	15
16	.....do	....	1	1	....	....	....	.....do	1
20	Jan. —, 1903	....	2	2	....	....	....	June 30, 1903	2
38	.....do	....	1	1	....	....	....	.....do	1
....	.....do	....	2	2	....	....	....	.....do	2
18	Feb. —, 1903	....	2	2	....	....	....	.....do	2
18	.....do	....	2	2	....	....	....	.....do	2
18	.....do	....	4	4	....	....	....	....	4
18	.....do	....	2	2	....	....	....	.....do	2
18	.....do	....	4	4	....	....	....	.....do	4
22	Nov. —, 1902								
15	Dec. —, 1902	....	6	6	....	....	....	.....do	6
18	Jan. —, 1903								
19	.....do								
16	May —, 1903	....	1	1	....	....	....	.....do	1
16	.....do	....	1	1	....	....	....	.....do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
State Dining Room.					
Chairs, oak, carved, armchairs, velvet cushions.	6	1902–3	$160.00	$960.00	A. H. Davenport, 96 Washington street, Boston, Mass.
Chairs, high back, no arms, tapestry covered, mahogany.	50	1902–3	40.00	2,000.00	.....do..........
Table, mahogany, extension, oblong shape, rounded corners.	1	1902–3	....	425.00	.....do..........
Long sideboard, mahogany, carved eagle legs, marble top, brass trimmings.	1	1902–3	....	650.00	.....do..........
Serving tables, "Console" tables, mahogany, carved eagle supports.	2	1902–3	310.00	620.00	.....do..........
Curtains, for windows....................pair..	5	1902–3	225.00	1,125.00	.....do..........
Stuffed head, wild bison........................	1	1902–3	....	2,000.00	Wm. W. Hart, 47 East Twelfth street, New York.
Stuffed head, white Alaska sheep..............	1				
Stuffed head, elk..............................	1				
Stuffed head, caribou..........................	2				
Stuffed head, antelope.........................	1				
Stuffed head, mountain sheep...................	1				
Stuffed head, giant Alaska moose...............	1				
Stuffed head, mountain lion....................	1				
Stuffed head, grizzly bear.....................	1				
Stuffed head, Kadiak Island bear...............	1				
Tapestry, panel (north side)...................	1	1902–3	....	550.00	A. Kimbel & Sons, 398 Fifth avenue, New York.
Rug, plain green, 24 x 37 feet.................	1	1902–3	....	1,332.00	Van Gaasbeek & Arkell, 159 Fifth avenue, New York.
Screen..	1	1902–3	....	310.00	A. H. Davenport, Boston.
Fireplace fixtures, wrought iron, large.......	1	Mar. 7, 1903	....	341.00	L. Marcotte & Co., New York.
Fire dogs.. / Fire set.... } iron.....................pair..	1 / 1	....do......	....	90.00	.....do..........
Screen, metal, folding, finished black........	1	.....do......	....	28.00	.....do..........
Pantry.					
Plate warmer, electric.........................	1	1902–3	....	539.75	H. Alexander, New York.
Refrigerator...................................	1	....	....	86.25	W. B. Moses & Sons, Washington.
Private dining room.					
Sideboard, mahogany............................	1	1902–3	....	375.00	A. H. Davenport, 96 Washington street, Boston, Mass.
Table, extension, mahogany.....................	1	1902–3	....	210.00	.....do..........
Table, "Console," mahogany.....................	1	1902–3	....	180.00	.....do..........
Cabinet for china, mahogany....................	1	1902–3	....	320.00	.....do..........
Mirror, mahogany and gold, "Colonial".........	1	1902–3	....	140.00	.....do..........
Chairs, mahogany and leather...................	10	1902–3	35.00	350.00	.....do..........
Chairs, mahogany, with arms, leather upholstered.	2	1902–3	40.00	80.00	.....do..........
Curtains for windows....................pairs..	2	1902–3	225.00	450.00	.....do..........
Rug, Yaprae, 15 feet 5 inches by 19 feet 9 inches.	1	1902–3	....	350.00	Van Gaasbeek & Arkell, 159 Fifth avenue, New York.
Mirror, French gold............................	1	1902–3	....	325.00	Doll & Richards, 2 Park street, Boston.
Serving table, mahogany........................	1	1902–3	....	110.00	A. H. Davenport, Boston.
Folding screen, brass, for fireplace...........	1	Mar. —, 1903	....	12.00	L. Marcotte & Co., New York.

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
35	Jan. —, 1903	....	6	6	....			June 30, 1903	6
35	.....do	....	50	50	....			.....do	50
35	.....do	....	1	1	....			.....do	1
35	.....do	....	1	1	....			.....do	1
35	.....do	....	2	2	....			.....do	2
35	.....do	....	5	5	....			.....do	5
21	Nov. —, 1902	....	1	1	....			.....do	1
			1	1	....			.....do	1
			1	1	....			.....do	1
			2	2	....			.....do	2
			1	1	....			.....do	1
			1	1	....			.....do	1
			1	1	....			.....do	1
			1	1	....			.....do	1
			1	1	....			.....do	1
			1	1	....			.....do	1
12	Dec. —, 1902	....	1	1	....			.....do	1
13	.....do	....	1	1	....			.....do	1
53	Mar. —, 1903	....	1	1	....			.....do	1
16	May, —, 1903	....	1	1	....			.....do	1
16	.....do	....	1	1	....			.....do	1
			1	1	....			.....do	1
16	.....do	....	1	1	....			.....do	1
16	Dec. —, 1902	....	1	1	....			June 30, 1903	1
39	Jan. —, 1903	....	1	1	....			.....do	1
102	Jan. —, 1903	....	1	1	....			June 30, 1903	1
102	.....do	....	1	1	....			.....do	1
102	.....do	....	1	1	....			.....do	1
102	.....do	....	1	1	....			.....do	1
102	.....do	....	1	1	....			.....do	1
102	.....do	....	10	10	....			.....do	10
102	.....do	....	2	2	....			.....do	2
102	.....do	....	1	2	....			.....do	2
13	Dec. —, 1902	....	1	1	....			.....do	1
11	.....do	....	1	1	....			.....do	1
102	Jan. —, 1903	....	1	1	....			.....do	1
16	Mar. —, 1903	....	1	1	....			.....do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost. Unit.	Cost. Total.	Bought from—
FIRST FLOOR—continued.					
Private dining room—Continued.					
Screens, white silk	12	May —, 1903	$2.50	$30.00	Edw. F. Caldwell & Co., New York.
Ushers' room.					
Rug, Ouchac	1	1902-3	....	120.00	Van Gaasbeek & Arkell, 159 Fifth avenue, New York.
Curtains, window, red flax velours, lined with silk, interlined with flannel, trimmed with fringe, center tassels, cord loops with slides, carved walnut poles, pair.	1	1902-3	....	191.31	L. Marcotte & Co.
Revolving chair, mahogany, No. 1072	1	1902-3	....	32.00	W. B. Moses & Sons, Washington.
Desk, mahogany, No. 292	1	1902-3	....	88.00	.....do
Side chairs, mahogany, No. 482	2	1902-3	11.50	23.00	.....do
Armchair, mahogany, No. 482	1	1902-3	....	16.00	.....do
Table, mahogany, No. 1487	1	1902-3	....	45.00	.....do
Main corridor.					
Rug, plain red, 12 by 73 feet	1	1902-3	....	1,314.00	Van Gaasbeek & Arkell, 159 Fifth avenue, New York.
Electric standards, 10 lights, dark fire gilt, lily shades.	6	1902-3	400.00	2,400.00	E. F. Caldwell & Co., New York.
Banquettes, richly carved French walnut, stuffed plain, covered with red silk velours, finished with gimp and large nails; loose covers of red linen.	12	1902-3	....	1,379.31	L. Marcotte & Co., New York.
Curtains, East Room and State Dining Room doors, red velours, lined with silk, interlined with double flannel, trimmed with rich fringe, silk center tassels, silk cord loops with slides, poles, pairs.	2	1902-3	....	309.00	.....do
Vestibule.					
Jardinieres, Istrian marble, white Zinc cases for same	2 2	1902-3	325.00	650.00	Piccirilli Bros., New York.
Electric lantern, 12 lights, antique gold, glass panels, candelabra lamps.	1	1902-3	....	425.00	E. F. Caldwell & Co., New York.
Electric standards, 10 lights, dark fire gilt, lily shades.	4	1902-3	400.00	1,600.00	.....do
Curtains, window, each side north door, red velours, lined with silk, interlined with double flannel, trimmed with rich fringe, silk center tassels, silk cord loops with slides, poles, pairs.	2	1902-3	....	309.00	L. Marcotte & Co., New York.
North portico.					
Electric lantern, 18 lights, fire gilt, glass panels.	1	1902-3	....	500.00	E. F. Caldwell & Co., New York.
Trees, bay, pairs	2	May 1, 1903	250.00	500.00	Fredk. R. Newbold, Poughkeepsie, N. Y.
SECOND FLOOR.					
Oval library.					
Kidney desk, mahogany	1	1902-3	....	65.00	W. B. Moses & Sons, Washington.
President's study.					
Rug, Wilton, carpet	1	1902-3	....	160.32	Arnold, Constable & Co., New York.
Curtains, window curtains, brown velour, poles, cords, etc., pairs.	2	1902-3	....	....	Theo. Hofstatter & Co., New York.

Executive Mansion June 30, 1903—Continued.

Voucher. No	Voucher. Date.	On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand. Date.	On hand. Quantity.
20	Aug. —, 1903	....	12	12	....	....	....	June 30, 1903	12
35	Dec. —, 1902	....	1	1	....	....	....	June 30, 1903	1
22 15 18, 19	Nov. —, 1902 Dec. —, 1902 Jan. —, 1903	....	1	1	....	....	....	.....do.......	1
39	.....do.......	....	1	1	....	....	....	.....do.......	1
39	.....do.......	....	1	1	....	....	....	.....do.......	1
39	.....do.......	....	2	2	....	....	....	.....do.......	2
39	.....do.......	....	1	1	....	....	....	.....do.......	1
39	.....do.......	....	1	1	....	....	....	.....do.......	1
13	Dec. —, 1902	....	1	1	....	....	....	June 30, 1903	1
72 17	.....do....... Mar. —, 1903	....	6	6	....	....	....	.....do.......	6
22 15 18 19	Nov. —, 1902 Dec. —, 1902 Jan. —, 1903 .....do.......	....	12	12	....	....	....	.....do.......	12
Same as	above	....	2	2	....	....	....	.....do.......	2
7	Feb. —, 1903	....	2	2	....	....	....	June 30, 1903	2
			2	2	....	....	....	.....do.......	2
73 16	Dec. —, 1902 Mar. —, 1903	....	1	1	....	....	....	.....do.......	1
72 17	Dec. —, 1902 Mar. —, 1903	....	4	4	....	....	....	.....do.......	4
22 15 18 19	Nov. —, 1902 Dec. —, 1902 Jan. —, 1903 .....do.......	....	2	2	....	....	....	.....do.......	2
72 17	Dec. —, 1902 Mar. —, 1903	....	1	1	....	....	....	June 30, 1903	1
39	June —, 1903	....	2	2	....	....	....	.....do.......	2
39	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
34	Dec. —, 1902	....	1	1	....	....	....	June 30, 1903	1
15	Jan. —, 1903	....	2	2	....	....	....	.....do.......	2

Inventory of public property in the

Description.	Number or quantity.	Received	Cost. Unit.	Cost. Total.	Bought from—
SECOND FLOOR—continued.					
President's study—Continued.					
Bookcase, oak	1	1902-3	....	$315.00	A.H Davenport, Boston.
Electric desk lamp, 2 lights, dark fire gilt, and shades.	1	....	....	40.00	E. F. Caldwell & Co., New York.
Large southwest bedroom.					
Sofa, in cotton	1	1902-3	....	80.00	A.H.Davenport, 96 Washington street, Boston.
Curtains for windows, cream-ground silk, lined with satinet, interlined with flannel, front and bottom ornamented with gimp, cord loops with slides, center tassels, pairs.	2	1902-3	....	289.60	L. Marcotte & Co. New York.
Large northeast bedroom.					
Bedstead, mahogany, canopy, draped	1	1902-3	....	....	Presented by Mrs. H. B. F. Macfarland, wife of Commissioner of District of Columbia.
Table, mahogany, toilet	1	1902-3	....	165.00	A.H.Davenport, 96 Washington street, Boston, Mass.
Mirror, mahogany, gilt	1	1902-3	....	110.00	.....do
Mirror, mahogany, cheval glass	1	1902-3	....	125.00	.....do
Wardrobe, mahogany	1	1902-3	....	480.00	.....do
Table, mahogany, writing	1	1902-3	....	125.00	.....do
Table, mahogany, night	1	1902-3	....	40.00	.....do
Table, mahogany, round	1	1902-3	....	70.00	.....do
Bureau, mahogany, chest of drawers	1	1902-3	....	160.00	.....do
Washstand, mahogany	1	1902-3	....	95.00	.....do
Carpet	1	1902-3	....	160.00	.....do
Curtains, white-ground materials, lined, complete, pair.	2	1902-3	....	263.12	L. Marcotte & Co., New York.
Small northeast bedroom.					
Bedstead, 4-0, brass	1	1902-3	....	50.00	A.H.Davenport, 96 Washington street, Boston, Mass.
Bed spring, upholstered	1	1902-3	....	30.00	.....do
Mattress	1	1902-3	....	30.00	.....do
Bureau, painted	1	1902-3	....	165.00	.....do
Table, painted, writing	1	1902-3	....	60.00	.....do
Table, painted, night	1	1902-3	....	45.00	.....do
Chairs, painted, light	2	1902-3	$25.00	50.00	.....do
Carpet	1	1902-3	....	84.00	.....do
Curtains, cretonne .... pair..	2	1902-3	60.00	120.00	Theo. Hofstatter & Co., New York.
Large southeast bedroom.					
Bed—Mahogany, canopy Bed—Drapery for same, muslin	1	1902-3	....	340.00 90.00	A.H.Davenport, 96 Washington street, Boston, Mass.
Bed spring, upholstered	1	1902-3	....	45.00	.....do
Mattress	1	1902-3	....	50.00	.....do
Toilet table, mahogany	1	1902-3	....	160.00	.....do
Mirror, gilt, mahogany, "colonial"	1	1902-3	....	110.00	.....do
Mirror, cheval glass, mahogany	1	1902-3	....	140.00	.....do
Wardrobe, mahogany	1	1902-3	....	350.00	.....do
Table, mahogany, writing	1	1902-3	....	120.00	.....do
Table, mahogany, night	1	1902-3	....	40.00	.....do
Table, mahogany, round	1	1902-3	....	55.00	.....do

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
102	Jan —, 1903	....	1	1	....	....	....	June 30, 1903	1
73 16	Dec. —, 1902 Mar. —, 1903	...	1	1	...	....	....	....	1
35	Jan. —, 1903	....	1	1	...	....	....	June 30, 1903	1
19	.....do	....	2	2	....	....	....	.....do	2
....	....	....	1	1	....	....	....	June 30, 1903	1
35	Jan. —, 1903	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
....	....	....	1	1	....	....	....	.....do	1
19	Jan. —, 1903	....	2	2	....	....	....	.....do	1
35	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	2	2	....	....	....	.....do	2
35	.....do	....	1	1	....	....	....	.....do	1
15	.....do	....	2	2	....	....	....	.....do	1
35	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1
35	.....do	....	1	1	....	....	....	.....do	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
SECOND FLOOR—continued.					
Large southeast bedroom—Continued.					
Bureau, mahogany, chest of drawers	1	1902–3	....	$180.00	A.H.Davenport, 96 Washington street, Boston, Mass.
Sofa, in cotton	1	1902–3	....	80.00	.....do
Washstand, mahogany	1	1902–3	....	95.00	.....do
Carpet	1	1902–3	....	160.00	.....do
Curtains, white, ground material lined, complete, pairs.	2	1902–3	....	263.12	L. Marcotte & Co., New York.
Small southeast bedroom.					
Bed, 4–0 brass	1	1902–3	....	50.00	A.H.Davenport, 96 Washington street, Boston, Mass.
Bed spring, upholstered	1	1902–3	....	30.00	.....do
Mattress, hair	1	1902–3	....	30.00	.....do
Bureau, painted green and white	1	1902–3	....	165.00	.....do
Writing table, painted green and white	1	1902–3	....	60.00	.....do
Night table, painted green and white	1	1902–3	....	45.00	.....do
Chairs, painted green and white, in cotton	2	1902–3	$25.00	50.00	.....do
Carpet	1	1902–3	....	84.00	.....do
Curtains, rose armure ....pairs	2	1902–3	85.00	170.00	Theo. Hofstatter & Co., New York.
Small southwest bedroom.					
Curtains, cretonne ....pairs	2	1902–3	75.00	150.00	Theo. Hofstatter & Co., New York.
Large northwest bedroom.					
Curtains for windows, old material, interlined with old flannel, lined with new satinet, trimmed with fringe, gimp, cord, tassel loops and centers, new rods and fixtures, pairs.	2	1902–3	....	218.02	L. Marcotte & Co., New York.
Small northwest bedroom.					
Curtains, cretonne ....pairs	2	1902–3	75.00	150.00	Theo. Hofstatter & Co., New York.
Corridor, second floor.					
Curtains, for windows at east and west ends, pair.	2	1902–3	225.00	450.00	Theo. Hofstatter & Co., New York.
Bedroom west of cross hall.					
Curtains, cretonne ....pair	1	1902–3	....	75.00	Theo. Hofstatter & Co., New York.
Bedroom east of cross hall.					
Curtains, cretonne ....pair	1	1902–3	....	75.00	Theo. Hofstatter & Co., New York.
East end of corridor.					
Carpet	1	1902–3	....	160.00	A. H. Davenport, Boston.
Ushers' dressing room—basement.					
Wardrobes, golden oak	2	1902–3	20.00	40.00	W. B. Moses & Sons, Washington.
Boiler room—basement.					
Pump, electric	1	1902–3	....	443.00	H. Alexander, New York.

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
35	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
19	.....do.......	....	2	2	....	....	....	.....do.......	2
85	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	1	1	....	....	....	.....do.......	1
35	.....do.......	....	2	2	....	....	....	.....do.......	2
35	.....do.......	....	1	1	....	....	....	.....do.......	1
15	.....do.......	....	2	2	....	....	....	.....do.......	2
15	Jan. —, 1903	....	2	2	....	....	....	June 30, 1903	2
18	Feb. —, 1903	....	2	2	....	....	....	June 30, 1903	2
15	Jan. 6, 1903	....	2	2	....	....	....	June 30, 1903	2
15	Jan. —, 1903	....	2	2	....	....	....	June 30, 1903	2
15	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
15	Jan. —, 1903	....	1	1	....	....	....	June 30, 1903	1
....	....	....	1	1	....	....	....	June 30, 1903	1
39	Jan. —, 1903	....	2	2	....	....	....	June 30, 1903	2
16	Dec. —, 1902	....	1	1	....	....	....	June 30, 1903	1

Inventory of public property in the

Description.	Number or quantity.	Received.	Cost.		Bought from—
			Unit.	Total.	
BASEMENT—continued.					
Steward's room—basement.					
Refrigerator, oak (cold storage)	1	Nov. 18, 1902	....	$985.00	The Lorillard Refrigerator Co., 23 West 34th street, New York.
West terrace.					
Fountain, white marble	1	1902-3	....	325.00	Piccirilli Bros., New York.
Plant boxes, tile front, with duplicate inner boxes of zinc.	20	June —, 1903	$19.00	380.00	Wm. S. Hutchinson, Washington.
Settees, stone (servants' dining room)	6	.....do	....	605.00	Jas. Sinclair & Co., New York.
Table, extension, 8-foot, golden oak	1	1902-3	....	16.00	W. B. Moses & Sons.
Sideboard, golden oak	1	.....do	....	16.00	.....do
East terrace.					
Fountain, white marble	1	1902-3	....	325.00	Piccirilli Bros., New York.
Plant boxes, tile front, with duplicate inner boxes of zinc.	20	June —, 1903	19.00	380.00	Wm. S. Hutchinson, Washington.
Settees, stone	6	.....do	....	605.00	Jas. Sinclair & Co., New York.
East and west terraces.					
Trees, bay trees	25	May 1, 1903	92.50	2,312.50	Fredk. R. Newbold, Poughkeepsie, N. Y.
Trees, bay trees	6	.....do	35.00	210.00	.....do
Trees, boxwood trees	24	.....do	1.00	24.00	.....do
Trees, boxwood trees	24	.....do	2.00	48.00	.....do
Trees, boxwood trees	24	.....do	3.50	84.00	.....do
Tree, standard, bay tree	1	June 27, 1903	....	46.25	Bobbink & Atkins, Rutherford, N. J.
Trees, pyramid bay trees	2	.....do	17.50	35.00	.....do
Miscellaneous.					
Mirror, toilet	1	Feb. 17, 1903	....	7.00	W. B. Moses & Sons, Washington.
Costumers, mahogany	3	.....do	18.90	56.70	.....do
Bench, oak, with green velour cushion	1	.....do	....	44.00	.....do
Screen, 4-fold, covered with rep	1	.....do	....	45.00	.....do
Screen, 4-fold, covered with tapestry	1	.....do	....	45.00	.....do
Shades, for windows on first and second floors, basement, and attic, mounted on rollers and hung.	....	Nov. —, 1902	....	398.75	L. Marcotte & Co., New York.
Curtains, red, flax velour lined with silk, put up with poles, pair.	1	Dec. —, 1902	....	368.61	.....do

Executive Mansion June 30, 1903—Continued.

Voucher.		On hand last return.	Received since last return.	Total to be accounted for.	Disposed of since last return.	Method and date of disposal.	Authority for disposal.	On hand.	
No.	Date.							Date.	Quantity.
86	Nov. 29, 1902	....	1	1	....			June 30, 1903	1
19	Feb. —, 1903	....	1	1	....			June 30, 1903	1
37	June —, 1903	....	20	20	....			.....do......	20
19	Aug. —, 1903	....	6	6	....			.....do......	6
39	Jan. —, 1903	....	1	1	....			.....do......	1
39	.....do......	....	1	1	....			.....do......	1
19	Feb. —, 1903	....	1	1	....			June 30, 1903	1
37	June —, 1903	....	20	20	....			.....do......	20
19	Aug. —, 1903	....	6	6	....			.....do......	6
39	June —, 1903	....	25	25	....			June 30, 1903	25
39	.....do......	....	6	6	....			.....do......	6
39	.....do......	....	24	24	....			.....do......	24
39	.....do......	....	24	24	....			.....do......	24
39	.....do......	....	24	24	....			.....do......	24
18	Aug. —, 1903	....	1	1	....			.....do......	1
18	.....do......	....	2	2	....			.....do......	2
19	Mar. —, 1903	....	1	1	....			June 30, 1903	1
19	.....do......	....	3	3	....			.....do......	3
19	.....do......	....	1	1	....			.....do......	1
19	.....do......	....	1	1	....			.....do......	1
19	.....do......	....	1	1	....			.....do......	1
19	Jan. —, 1903	....	....	....	....			.....do......	.....
19	.....do......	....	1	1	....			.....do......	1

Appendix B.

NOTES ON PUBLIC PLAYGROUNDS, ETC., BY GEORGE H. BROWN, LANDSCAPE GARDENER.

It is now generally recognized that street play is in a large measure an evil and that the space between curbs is altogether too narrow and confined for the physical development of child life. Philadelphia, New York, Boston, and Buffalo, in the East and North, and a number of our large cities in the West and South, have made commendable progress in establishing playgrounds in the thickly settled sections of their cities, and open air spaces have also been set apart in the parks and park places of very many other smaller cities where children and young people of more advanced age can gather and romp and play games, etc., under only such limited restrictions as are found to be necessary for their protection and well-being. In connection with this work and in furtherance of it many city governments have made liberal appropriations for increasing the number of their playgrounds, providing gymnastic apparatus, swings, seesaws, sand heaps, and other good things for the children's recreation and enjoyment.

Washington is not yet densely populated; we have no tenement-house districts like Chicago and New York, and our open air spaces are abundant, dotting the intersections of streets and avenues in every section of the city. This in a large measure has prevented the excitement incident to the playgrounds movement in other cities from reaching us to any great extent. Our parks, squares, circles, and small parklets comprise in all about 300 reservations and are so widely distributed that few sections of Washington are without them; but it has been heretofore deemed advisable to highly improve them that they might add to the general attractions of our national capital, and as means have been provided by Congress this purpose has been carried into effect, mainly under the direction of engineer officers of the United States Army, placed by Congress in their control and management. These reservations vary widely in extent, from a little over 60 acres to plots of less than 1,000 square feet, and are prized by our people and many visitors as charming bits of nature, forming pleasing contrasts to their brick and stone surroundings, and in this connection, from a practical as well as an æsthetic point of view, their value can hardly be overestimated. Trees, shrubs, and flowers planted in them not only furnish shade and beauty to adorn our city landscapes, but they also in some measure purify the atmosphere our city folks breathe, and to the lover of nature they are full of suggestiveness, awakening new thoughts and affording desirable mental exercise in studying their varying character as developed by the changing seasons.

In a limited sense also our city parks have afforded a substitute for playgrounds for very young children, especially in the early summer and autumn months, when the little people run over the lawns in every direction and rest in the shade of the trees under the watchful care of their guardians, for, by the direction of the officer in charge, no restrictions are permitted to be placed upon their free movements; but the accessories of playgrounds—sand heaps, hammocks, swings, etc., which add so much to their enjoyment—are necessarily altogether wanting, and for boys and girls of more advanced age the improved public park can in no way be considered as a substitute for a modern playground.

An act of Congress, approved August 30, 1890, authorized the officer in charge of public buildings and grounds to use temporarily portions of the Washington Monument grounds, the grounds south of the Executive Mansion, or other reservations in the District of Columbia for children's playgrounds, under regulations to be prescribed by him, but no appropriation was made for the preparation of these grounds for shelter, etc., or for apparatus to fit them for general use as playgrounds. Subsequently a section of the Monument Park of nearly even grade and about 8 acres in area was set apart for this purpose, and it has been very generally used for football and baseball grounds by young men and boys of advanced growth from that period to the present time. Young children do not frequent these playgrounds to any extent, no means having been available to make proper provision for their comfort and care.

In 1899 an improved reservation in southeast Washington (Virginia avenue between Ninth and Eleventh streets), comprising an area of about 2 acres, was graded nearly level, and all rubbish, loose stones, etc., removed therefrom and goal posts erected for football games. This reservation has been very generally used since that period for ball games, but, as in the case of the Washington Monument grounds, by young men and boys of larger growth.

The public playgrounds of the Eastern and Western cities before referred to are of various classes, ranging in area from 4,000 square feet to 20 acres.

Those of the smallest classes are usually reserved for children and are furnished with box and basket swings, seesaws, sand boxes, and seats for their parents or guardians, and are frequently inclosed with hedges or fences.

The intermediate classes are for boys and girls of more advanced age and are furnished with climbing ladders, balance bars, pole swings or "giant strides" as they are called from the long strides the boys and girls make as they swing from the ropes going round them, and a more or less complete gymnasium outfit.

A hundred children can readily play in those of the smallest classes, and 1,000 or more in the intermediate classes can find enjoyment and abundant healthy exercise.

Those of the largest extent have thoroughly equipped gymnasiums, tennis courts and ball grounds, etc., buildings for shelter, watchmen's lodges, bathing pools (which are used for skating ponds in winter), quoit grounds, bicycle tracks, and pedestrian race tracks, etc.

The following are brief descriptions of the three classes of playgrounds:

The smallest classes (usually city lots, from 4,000 to 8,000 square feet) are roughly graded, coated with ashes and rolled to a smooth surface, furnished with 2 sand boxes, 2 giant strides, 1 slide, 4 seesaws, 4 swings, 2 balance swings, and 4 parallel bars, containing a lightly constructed shed at one end for shelter in sudden rainstorms and inclosed with a rough board fence. The cost of preparing and furnishing this class of playgrounds, which will accommodate 100 children, is approximately $500.

In Buffalo the boulevard parks in a densely populated section constitute playgrounds of the intermediate classes. A street crossing this boulevard forms a dividing line. On one side of this street the playground is furnished with chair swings and sand boxes for small children and pole swings, etc., for older children, and is reserved for girls and women. On the other side the playground is equipped with gymnastic appliances, including ladders, parallel bars, running track, etc., and is reserved for boys and men. The cost of the apparatus for these two public playgrounds was $1,000. Their average daily attendance is about 7,000 persons.

One of the playgrounds in Philadelphia of the largest class is described as follows:

"In the middle is an open circular area, to be flooded during the skating season and used as a romping ground during the rest of the year. This is surrounded by a bicycle track, fenced for safety. Outside of this are found various provisions for children's enjoyment, such as tennis courts, parallel bars, swinging rings, and sand piles; also a music stand, sanitary provisions, etc.

"All is surrounded by a promenade path, where mothers may wheel their baby carriages and where rows of seats invite the visitor to rest under overhanging shade trees. Two sides of this playground have each a pavilion, one for boys and the other for girls. These are designed to supply the place of the playground in winter and during stormy weather."

The regulations prescribed by the park commissioners of Buffalo, N. Y., may be taken to illustrate the regulations generally prescribed for the government of public playgrounds in other cities, and are as follows:

"I. The playgrounds shall be under the immediate charge and direction of a superintendent and such other assistants to be appointed by the park commissioners.

"II. The superintendent is responsible for the maintenance of order and decorum and for the exercise of discretion and civility in all use to be made of the playgrounds. His authority corresponds with his responsibility. No one is to enter the playgrounds when forbidden by him; no one is to remain in it when desired by him to leave. Report may be made to the park commissioners whenever the superintendent is thought to have used his authority unjustly, but his authority is not to be resisted or impugned by visitors on the grounds.

"III. All persons using the playgrounds do so at their own risk. Neither the city nor the park commissioners shall be liable for any injury to any person incurred in the use of the playgrounds.

"IV. The playgrounds shall be open from 8 a. m. till half hour after sunset daily, except that the use of the gymnastic apparatus shall not be permitted on Sundays or when the weather is unsuitable.

"V. Smoking, boisterous conduct, and the use of vulgar or profane language on the playgrounds is absolutely forbidden.

"VI. No one is to occupy the playgrounds except while making use of some of its apparatus, or while waiting opportunity to do so, or for a reasonable breathing time between exercises. Wheeling entirely prohibited on any part of the playgrounds.

"VII. No part of the person usually clothed within doors is to be exposed while in the playgrounds, except athletes in costume, subject to superintendent's approval.

"VIII. No person is to use any piece of the apparatus to the exclusion of another person beyond a reasonable time. In cases of dispute the superintendent will decide what is a reasonable time.

"IX. No person is to engage in dangerous exercises. If the superintendent judges any form of exercise by any person to be dangerous, it is to be considered so and refrained from by that person.

"X. No part of the apparatus is to be put to other than its proper use or to be used with excessive violence.

"XI. In any use of the track the right side of the person is to be kept toward the fence line.

"XII. Persons not engaged in putting the shot or hammer are to avoid the ground assigned to those who are so engaged.

"XIII. Any person violating either of the above rules is liable to a fine not to exceed $20 for each offense, and will forfeit the right to the use of the playgrounds for the season."

Washington is in many respects the ward of the nation. A large portion of its area, comprising its avenues and streets, parks, park places, and numerous unimproved and partly improved public spaces, together with the magnificent and costly public buildings, are the property of the nation. Progressive city improvements, and especially modern park creations, which are carried forward to successful issue by municipal authority and private enterprise in other prominent American cities, are accomplished here mainly through Government aid. It is apparent, therefore, that public playgrounds as an addition to our present park system, and which an almost universal sentiment indicates as a very near, if not an actual, present and imperative need, must be a further provision for Washington by the General Government, and Congress will have to provide in large measure the means for their creation, maintenance, and permanent support.

In this connection it is a fortunate circumstance that it will not be necessary to dispense with any of our highly improved parks or park places, in which our people take so much pride, for there are numerous unimproved and comparatively unimproved public spaces of sufficient area located in the northern, southern, eastern, and western sections of the city that can be converted into model playgrounds of the various classes before described, many of which can be reached by present car lines, and all of which will doubtless be easily accessible in the near future, for which we must now provide.

The following unimproved and comparatively unimproved public spaces, embracing nearly all sections of the city which are being rapidly built up, are in many respects desirable locations for such public playgrounds:

Reservation 170, Vermont avenue between T and U streets; area, 11,695 square feet.

Reservation 178, New York avenue between Fourth and Fifth streets; area, 7,181 square feet.

Reservation 133, New Hampshire avenue between Twenty-fifth and Twenty-sixth streets west; area, 8,816 square feet.

Reservation 105, Virginia avenue between Twentieth and Twenty-first streets; area, 11,096 square feet.

Reservation 185, Florida avenue between First and Second streets east; area, 7,618 square feet.

Reservation 228, Delaware avenue between M and N streets north; area, 7,093 square feet.

Reservation 219, Delaware avenue between I and K streets south; area, 25,642 square feet.

Reservation 244, Georgia avenue and R street south; area, 20,234 square feet.

Reservation 122, Virginia avenue between Fourth and Fifth streets east; area 15,916 square feet.

Reservation 126, on Virginia avenue between Ninth and Eleventh streets southeast, already set aside as a playground, should receive further improvement and be equipped with modern appliances that are suitable for children's playgrounds.

Playgrounds of the largest class which contain so many desirable park features as to become places of public resort might be located in Howard University Park, (reservation 20), between Fourth and Fifth streets and College and Pomeroy streets, comprising an area of nearly 12 acres. This reservation is partly covered by a native forest growth and is easy of access, being in close proximity to the terminal stations of four of our city and suburban street railroad lines, and it is of sufficient extent to include picnic grounds and ball grounds and well-equipped playgrounds. A section of Potomac Park of about an equal area to Howard University Park should be devoted to a like purpose for south and west Washington.

Parks combining playgrounds and abundant space to serve also as places of public resort are now found in and bordering many of the crowded cities of both our own country and Europe, and in some cases are well illuminated and are open at night, affording very desirable and healthful resorts for outpourings of their surcharged populations.

Public parks of a very much more extensive character with broad expanses of meadow land, lakes fringed with trees and shrubs, wide, well-shaded driveways, bridle paths, and walks for general travel, etc., are now found bordering the metropolitan cities of Europe and many of the large cities of the United States.

London, England, has over 33,000 acres devoted to parks, park places, and playgrounds, and from a pamphlet lately published I find that four millions of dollars was recently expended by its municipal government to procure a small (so called) breathing space in a congested part of that city. Boston, New York, Philadelphia, Chicago, and other large American cities have each expended many millions of dollars in accomplishing their park creations, and are now opening in their congested sections small playgrounds, which require a very large expenditure of money. Ten such small spaces opened in Chicago cost over a million of dollars, and the Hon. Jacob Riis, in his book on the slums of New York City, states that similar creations in congested sections of New York City cost over a million of dollars each.

In Washington, if Government reservations should be used, the main outlay, the purchase of land, would not be required. The cost of construction alone would have to be provided by Congress, which for the smaller public playgrounds would be approximately from \$500 to \$1,000 each, and for the two combined parks, Howard University Park and Potomac Park, approximately \$20,000 each.

Respectfully submitted.

Geo. H. Brown,
Landscape Gardener.

Appendix C.

NOTES ON CODIÆUMS, A GENUS OF VERY ORNAMENTAL TROPICAL PLANTS, NUMEROUS VARIETIES OF WHICH ARE GROWN AT THE PROPAGATING GARDENS OF THE PUBLIC GROUNDS, BY GEORGE H. BROWN, LANDSCAPE GARDENER.

The name Codiæum is derived from the Malayan name given to one of the species indigenous to that country, but these plants are more generally known by the popular name of Crotons, from which family, however, they are now known to be botanically distinct. The genus comprises four species of shrubby Euphorbiaceous plants indigenous in the Malayan Archipelago, the Pacific islands, and the tropical sections of Australia and South America.

Codiæum variegatum, one of the first varieties introduced into the United States, constitutes a political emblem in Brazil, the green and yellow of its leaves and stems approximating the blending of the national colors.

The numerous varieties now grown by commercial florists and the extensive collections of this class of plants in the principal garden establishments of Europe and America have been obtained chiefly by hybridization and from sports (branches and offshoots varying in character and markings of color from the parent plants), which, on being removed and propagated, retain the varied character.

Of the six new varieties shown in the frontispiece, Nos. 1, 2, and 3 are the result of successful crossing (hybridization) at our gardens, and Nos. 4, 5, and 6 are sports. Our collection at the propagating gardens comprises over seventy-five distinct varieties and is classed as one of the best collections in the United States.

The Codiæums are unexcelled by any other class of plants for the decoration of halls, churches, etc., on occasions of public assemblages; also for the embellishment of rooms and for dinner-table decorations, the brilliant combinations of colors displayed in their foliage ranging from light green and yellow to the deepest shades of orange, and from light pink and green to the deepest shades of crimson, making them especially attractive either when grouped alone or in combination with palms and ferns.

They are a most serviceable class of plants for furnishing conservatories during the summer and autumn months, thriving with indoor summer cultivation where other classes of plants fail. They are also an especially desirable class of plants for park decorations, either massed in groups or planted in beds with other foliage plants. When used for this purpose they should be hardened off in a cool greenhouse for a few weeks before the planting-out season for tropical plants, which in Washington is about the 1st of June.

Detailed description of plants shown in the group.

No. 1 Leaves broad, 12 inches long, richly variegated. Predominant colors: Light yellow, blending into orange, green, and red.

No 2 Leaves broad, 10 inches long, slightly twisted, richly variegated. Predominant colors: Yellow and green.

No 3 Leaves broad, 10 inches long, richly variegated with parallel stripes and blotches of yellow, creamy white, and green.

No. 4 Leaves narrow, pointed, 4 to 5 inches long, richly variegated by spots, blotches, and irregular markings of yellow on a green ground.

No. 5 Leaves broad, 9 inches long, richly variegated, the predominating colors being light yellow shaded to deep gold with only a narrow margin of green

No 6. Leaves broad, from 9 to 12 inches long, richly variegated. Colors: Light yellow, orange, and pink, shading to deep red and crimson.

APPENDIX F F F.

NORTHERN AND NORTHWESTERN LAKES—CORRECTING AND ISSUING CHARTS—SURVEYS—WATER LEVELS.

REPORT OF MAJ. WALTER L. FISK, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

United States Engineer Office,
Detroit, Mich., August 8, 1903.

General: I have the honor to submit herewith annual report on survey of the Northern and Northwestern Lakes for the fiscal year ending June 30, 1903. * * *

Very respectfully, your obedient servant,

W. L. Fisk,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

F F F 1.

NORTHERN AND NORTHWESTERN LAKES—CORRECTING AND ISSUING CHARTS—SURVEYS—WATER LEVELS.

As early as 1816 local surveys of the Great Lakes for special purposes were made by engineer officers, but the survey of the Northern and Northwestern Lakes, as a connected and systematic whole, was commenced in 1841 and prosecuted continuously until 1882, when work was suspended, as the data then in hand seemed sufficient for the requirements of navigation of the period. After the suspension and until 1889 operations were limited to the publication and issue of charts, $2,000 or $3,000 being appropriated annually for this work. In 1889 field operations were resumed under an appropriation made therefor, and have been continued under annual appropriations ranging from $5,000 to $25,000. In 1898 these operations were extended to include observations and investigations of lake levels, with a view to ascertaining the causes of changes in level, determining the hydraulic data needed for formulating the laws of interlake flow, and devising the most feasible method of lake-level maintenance or regulation, and the appropriations in 1900, 1901, 1902, and 1903 were increased to $75,000, $100,000, $150,000, and $150,000, respectively.

Operations during the last fiscal year have included work related to the several features above referred to, as follows:

Charts.—The following statement shows the number of charts received and disposed of at this office during the fiscal year ending June 30, 1903:

On hand July 1, 1902	13,440
Received from Chief of Engineers	5,898
Prepared in this office	26,446
Returned by United States engineer office, Buffalo, N. Y	20
	45,804
Sold	11,573
Issued for official use	2,868
Transferred to United States engineer office, Buffalo, N. Y	2,007
Destroyed, out of date	638
On hand July 1, 1903	28,718
	45,804

The total number of charts sold by this office during the year was 11,573, the total amount received from these sales being $2,009.05, which was duly deposited to the credit of the Treasurer of the United States. The total number of charts that have been sold, issued, and transferred through this office to June 30, 1903, is 271,076, including issues to the United States engineer office at Buffalo.

Extensive corrections and additions to copies of the following-named charts were made in this office and forwarded to the Office of the Chief of Engineers for the guidance of the engravers in correcting the copperplates, viz:

1. St. Clair River; scale 1:40000.
2. L'Anse and Keweenaw Bay; scale 1:30000.
3. Coast chart No. 5, Lake Michigan; scale 1:80000.

These corrections and additions included changes in aids to navigation, modifications due to river and harbor improvements, latest magnetic determinations, additional and corrected sailing courses, and the most prominent topographic and hydrographic changes developed by commercial and industrial enterprise on the shores of the lakes and their tributary and connecting rivers.

The changes constantly being made in lights and buoys render necessary a very large amount of hand word, as every chart is corrected for all information received to the very day it is sent out of the office.

In continuation of the policy of eventually issuing all lake-survey charts in colors, copperplates were revised and corrected in this office for transfer to stone and printing in colors, as follows:

1. Coast chart No. 1, Lake Ontario; scale 1:80000. Issued July 24, 1902.
2. St. Lawrence River No. 6; scale 1:30000. Issued July 25, 1902.
3. St. Lawrence River No. 5; scale 1:30000. Issued August 5, 1902.
4. Coast chart No. 5, Lake Erie; scale 1:80000. Issued August 27, 1902.
5. Coast chart No. 6, Lake Erie; scale 1:80000. Issued October 10, 1902.
6. Coast chart No. 7, Lake Erie; scale 1:80000. Issued October 20, 1902.
7. Coast chart No. 2, Lake Ontario; scale 1:80000. Issued November 20, 1902.
8. Detroit River, scale 1:40000, with lithograph inset "Lower Detroit River" on scale of 1:10000. To the inset were added soundings and contour lines from the latest ice surveys made in 1902 under the direction of Maj. W. H. Bixby, and also the new channel at Amherstburg reach with the changes in aids to navigation made October 22, 1902. The fourth revised edition in colors. Issued February 3, 1903.

9. St. Lawrence River No. 1; scale 1:30000. Results of resurvey of 1901 added, showing extensive changes in hydrography and topography. Issued May 8, 1903.
10. General chart of Lake Erie; scale 1:400000. The head of Detroit River, Lake St. Clair, and St. Clair River, including the foot of Lake Huron, were reduced, separately engraved on stone, and transferred to this chart, increasing both its value and appearance. The second edition in colors. Issued June 2, 1903.
11. St. Marys River No. 2; scale 1:40000. The portion of St. Joseph channel from Richards Landing to Wilson channel was added. The second edition from heliogravure plates. Issued June 30, 1903.
12. Straits of Mackinac; scale 1:120000. The revision of this plate for the second edition in colors, showing the three new shoals discovered last fall in the vicinity of Waugoshance by the Lake Survey party upon the steamer *Graham*, is nearly ready for transfer.
13. Lake St. Clair; scale 1:50000. Revision of the plate for the second edition in colors completed and transfer made. Will be issued by the middle of July.
14. Beaver Island group; scale 1:120000. The revision of a copy of this chart is completed and is now in the hands of the engraver for correction of the plate.
15. St. Lawrence River No. 2; scale 1:30000. Reductions from the detail sheets of the resurvey of 1901 have been completed and the revision of the plate will be taken in hand as soon as the engraver completes the work upon which he is now engaged.

Drawings were revised and reproduced on copper by heliogravure, transferred to stone, and printed in colors as follows:

1. Apostle Islands No. 2, including Chequamegon Bay; drawing, scale 1:40000, reproduced to scale 1:50000. Issued August 28, 1902.
2. Buffalo Harbor and Niagara River to the Falls; drawing, scale 1:25000, reproduced to scale 1:30000. The second edition in colors. Issued September 12, 1902.
3. Cleveland Harbor, Ohio; drawing, scale 1:10000, reproduced to scale 1:12000. The second edition in colors. Issued October 22, 1902.
4. St. Marys River No. 1; drawing, scale 1: 30000, reproduced to scale 1: 40000. Issued January 23, 1903.
5. General chart of Lake Michigan; drawing, scale 1:400000, reproduced to scale 1:500000. The second edition in colors. Issued March 31, 1903.

Revision of drawing for reproduction by heliogravure and printing in colors is in progress as follows:

1. Erie Harbor and Presque Isle, Pennsylvania; drawing, scale 1:10000; will be reproduced to scale 1:15000.

The following entirely new charts were completed and issued in colors during the year:

1. Charlotte Harbor, New York; scale, 1:5000. Engraved on stone. Issued July 23, 1902.
2. Marquette and Presque Isle harbors, Michigan; scale, 1:15000. Engraved on stone. Issued August 5, 1902.
3. Coast chart No. 8, north coast of Lake Huron from Lougheed Point to Scammon Cove, including North channel from Little Detroit to Sulphur Island; scale, 1:120000, with inset charts of Little Detroit on scale of 1:8000 and Serpent Harbor on scale of 1:30000. Engraved on stone. Issued October 8, 1902.
4. Great Sodus Bay, New York; scale, 1:10000. Engraved on stone. Issued December 19, 1902.
5. Lorain Harbor, Ohio; scale, 1:8000. Engraved on stone. Issued January 12, 1903.
6. General chart of Lake Huron; scale, 1:400000. Engraved on stone. Issued April 11, 1903.
7. St. Joseph channel and western end of North channel; scale, 1: 40000; with inset of Wilson channel on scale 1:24000. This chart connects Lake Huron coast chart No. 8 with St. Marys River charts Nos. 1 and 2, and upon it appear portions of the 1896 resurvey of St. Marys River not heretofore published. Engraved on stone. Issued April 27, 1903.
8. Coast chart No. 7, northeast coast of Lake Huron from Cape Hurd to Lougheed Point, including entrance to Georgian Bay and eastern end of North channel; scale, 1:120000, with inset charts of Killarney Harbor, Little Current, South Baymouth Harbor, Club Harbor, Tobermory Harbor, and Rattlesnake Harbor, all on scale of 1:24000. Engraved on stone. Issued May 7, 1903.

9. Oswego Harbor, New York; scale, 1:8000. Engraved on stone. Issued June 29, 1903.
10. Little Rapids, St. Marys River, Michigan, showing condition of available channel in April, 1903; scale, 1:24000.
11. Arcadia Harbor, Lake Michigan; scale, 1:10000.
12. Manistique Harbor, Lake Michigan; scale, 1:12000.

The last three mentioned were engraved on stone, printed in colors, and inserted in Bulletin No. 13, dated April 15, 1903, and are not considered as being part of the regular series of Lake Survey charts.

The photolithographing of manuscript charts has been entirely abandoned for the heliogravure process of mechanical reproduction on copperplates, from which transfers to stone are then made for printing, as in the case of the old engraved copperplates.

In addition to the foregoing the following new charts are well advanced:

1. St. Clair River, from Lake Huron light-ship to St. Clair Flats canal; scale, 1:40000; with insets of "St. Clair middle ground," "Marine City and vicinity," and "Russell Island shoals, including Algonac," all on scale of 1:16000. Final small surveys to complete this chart are now being made. Engraved on stone. Will be issued about September 1, 1903.
2. Coast chart No. 1, east end of Lake Superior, from Cape Gargantua, Ontario, to Two Hearted River, Michigan, including Whitefish Bay and head of St. Marys River; scale, 1:120000. This chart will include the results of the recent survey of the eastern coast of Lake Superior and the outlying islands and reefs. The reduction is nearly completed and the engraving on stone has made good progress.
3. Coast chart No. 5, Lake Huron, from Port Elgin to Cape Hurd, including southern portion of Georgian Bay to Parry Island; scale 1:120000. The reduction is completed and the engraving on stone has made good progress.

The reductions of the following new charts are ready for the use of the engravers, as the work on which they are now engaged is completed:

1. Harbor at Michigan City, Ind.; scale, 1:5000. Will be engraved on stone.
2. Ludington Harbor, Michigan; scale, 1:5000. All available data for this chart have been reduced, and the results of additional surveys to be made during the present month will be included. Will be engraved on stone.

The first editions of the following new charts engraved on stone having been exhausted, thoroughly revised second editions were issued:

1. Harbor at Duluth, Minn., and Superior, Wis.; scale, 1:18000. The revision for the second edition showed the results of the surveys made under direction of Capt. D. D. Gaillard during the winter of 1901–2. Issued July 22, 1902.
2. Ashtabula Harbor, Ohio; scale, 1:5000. Issued July 23, 1902.
3. Muskegon Harbor, Lake Michigan, including Muskegon Lake; scale, 1:5000. Issued August 29, 1902.
4. Maumee Bay and River, including city of Toledo, Ohio; scale, 1:25000. Issued November 13, 1902.

Revisions preparatory to new editions of the following charts are in hand:

1. Erie Harbor and Presque Isle; scale, 1:15000. For second edition.
2. Buffalo Harbor and Niagara River to the Falls; scale, 1:30000. For third edition.
3. Sturgeon Bay, Canal, and Harbor of Refuge; scale, 1:25000. For second edition.
4. Harbor at Duluth, Minn., and Superior, Wis.; scale, 1:18000. Showing results of surveys of the winter of 1902–3. For third edition.
5. Fairport Harbor, Ohio; scale, 1:8000. For second edition.
6. St. Marys River No. 3; scale, 1:40000. For second edition.

In addition to the three new small charts engraved on stone for insets in Bulletin No. 13, the following small charts were prepared

for insets in supplements Nos. 2, 3, and 4 to Bulletin No. 12, from transfers made partly from existing plates and partly from newly engraved supplementary stones:

1. New shoals near Waugoshance, Straits of Mackinac; scale, 1:120000, with inset on scale of 1:50000. A zinc etching made from a transfer of part of the copperplate of the chart of Straits of Mackinac and the inset engraved on stone. Printed in black in Supplement No. 2 to Bulletin 12, October 22, 1902.
2. Mouth of Black River shoal, St. Clair River, Michigan; scale, 1:120000. A photo-engraving from a special drawing reduced from survey of the shoal made in September, 1902. Printed in black in Supplement No. 2 to Bulletin 12, October 22, 1902.
3. Amherstburg reach, Lower Detroit River; scale, 1:15000. Photo-engraving prepared from lithographed inset of "Lower Detroit River," showing new channel and changes in the lights. Printed in black in Supplement No. 3 to Bulletin 22, October 30, 1902.
4. New shoals near Waugoshance, Straits of Mackinac; scale, 1:120000, with inset on scale of 1:50000. The discovery of a third new and important shoal by the Lake Survey made necessary a revision of the inset of same title above mentioned. Printed in colors in Supplement No. 4 to Bulletin 12, November 15, 1902.

The methods of work inaugurated two years ago have proven entirely successful and satisfactory, and will be continued, with such improvements as experience may suggest.

The reduction, preparation, and reproduction of charts has continued, as heretofore, under the immediate direction and supervision of Assistant Engineer Edward Molitor, and to him is due great credit for the unexpectedly large amount of satisfactory work turned out during the year.

Surveys.—The resurvey of Apostle Islands, Lake Superior, was continued by the party under Junior Engineer F. G. Ray from date of last year's report until completed, in October, and is a most satisfactory piece of work, for the details of which reference is made to the accompanying report of Mr. Ray. The triangulation system controlling this work is extremely good, as will be seen from the sketch accompanying Mr. Ray's report. All stations have been permanently marked, and the geodetic positions are also given, so future work of any kind in that vicinity will be greatly facilitated.

Returning to Detroit, Mr. Ray's party made a very careful examination of the course followed by vessels in the vicinity of Parisian Island, Whitefish Bay, where shoals have been several times reported. This examination covered an area of 15 square miles, 5 miles along the course laid down on the charts and 1½ miles in width on each side of it, and showed conclusively that the bottom found must have been due to the vessels being very much closer to Parisian Island than they supposed.

This party then made an examination for a shoal reported in Lake Huron off Alcona, Mich., and while no shoal could be found where reported one was developed at another point in that vicinity.

A resurvey of the shoal water lying along the mainland between Point Ausable and the town of Ausable, Mich. (Baltimore shoal), concluded the excellent season's work of this party.

At as early a date as possible this season Mr. Ray was sent with the steamer *Search* to commence the resurvey of the northern end of Green Bay and the passages into it from Lake Michigan. As there has been considerable trouble in this locality, it is intended that the work shall be very thorough, and a good start has been made.

The party under Assistant Engineer L. C. Sabin, which was working

in the northern end of Lake Michigan at the date of the last annual report, continued there until the middle of November, when the usual rough weather made it impossible to do satisfactory work and the party came in. During the latter part of the season three very dangerous new shoals were developed in the vicinity of Waugoshance, of which small maps were published in special bulletin supplements issued for the purpose. Mr. Sabin having transferred to another engineer office, Junior Engineer W. J. Graves will be in charge of this party this year.

The resurvey of St. Lawrence River, in progress by the party under Assistant Engineer F. C. Shenehon at the date of last report, was completed up to Clayton, N. Y., by the close of the season. It developed a great number of hitherto uncharted rocks and shoals which, with changes in some of the Canadian canals and much local topography, has made possible the thorough revision of the series of St. Lawrence River charts, which is now over one-half completed. From Clayton the resurvey will be continued to the open water of Lake Ontario after some more urgent work at other localities has been done.

This season Mr. Shenehon has been assigned to the resurvey of the western end of Lake Erie, which has been urgent for some years. The details of the St. Lawrence River work will be found in Mr. Shenehon's report herewith.

The party of Junior Engineer Murray Blanchard finished the discharge work on Detroit River last season, and also spent six weeks on St. Clair River discharge work, covering a stage of water which had not before been taken, and the results of these St. Clair River discharges will be found in the report of Assistant Engineer Thomas Russell upon the adjustment to standard datum of the triangulation of St. Clair and Detroit rivers, at page 2790, following.

Mr. Blanchard's party is this year engaged upon local surveys for new charts and correction of old ones.

Junior Engineer H. F. Johnson is this year continuing his work of last season in connecting the United States Lake Survey triangulation in the vicinity of the mouth of St. Marys River with the Canadian system along the northern coast of Lake Huron.

Junior Engineer M. S. MacDiarmid is engaged upon the triangulation for controlling the hydrographic work in northern Lake Michigan and for extending our system down the east shore of Lake Michigan.

A few magnetic observations were taken in the Apostle Islands by Mr. Ray, using the magnetometer, and a few on the St. Lawrence River with a transit by Mr. Shenehon's party.

At page 2787, following, will be found the report of Assistant Engineer Thomas Russell upon the reduction to standard datum of the triangulation of the resurveys of St. Clair River and Detroit River. There is herewith a chart showing all the completed triangulation work of the United States Lake Survey adjusted to standard datum. It should be published to complete the record of adjusted triangulation published in last year's report.

Precise levels.—The precise-level line connecting Greenbush bench mark at Albany with United States Lake Survey bench mark "A," at Oswego, commenced on July 1 of last year, was completed November 15 by Junior Engineer A. H. Horton, whose report thereon follows at page 2783.

It is a very creditable piece of work. Fully three-fourths is within

the error limits of

$$2 \text{ mm.} \sqrt{\text{distance between bench marks in kilometers}},$$

and only a very small fraction even approximates

$$3 \text{ mm.} \sqrt{\text{distance between bench marks in kilometers}},$$

the limit of error adopted.

The level rods were carefully tested weekly during the work, bringing out the interesting point that they constantly increased in length during the season.

The distance from Greenbush bench mark to bench mark "A," at Oswego, by the line followed, was 206.1 miles, progress thus averaging $1\frac{1}{2}$ miles of completed line for every day, making no allowance for Sundays, holidays, or bad weather.

Bulletins.—The bulletins of the Survey of Northern and Northwestern Lakes contain important data and information supplementary to the charts but of too voluminous a character to be incorporated thereon, and they are accordingly issued free in connection with the charts. Bulletin 12 of 1902, and those preceding it, were printed in Washington, but on July 10, 1902, the entire work of printing and issuing bulletins and supplements thereto was turned over to this office. The work of printing is now performed under contract.

Between September 23 and December 31, 1902, five supplements to Bulletin 12 were issued at intervals, as occasion demanded. A feature inaugurated in these supplements was that of including small inset charts showing newly developed shoals dangerous to navigation, or important changes in improved channels. A map of new shoals found by a Lake Survey party near Waugoshance, Straits of Mackinac, and a map of shoal in St. Clair River, off the mouth of Black River at Port Huron, were included in Supplement No. 2. An inset in Supplement No. 3 showed the development of improvements at Amherstburg reach, lower Detroit River, and Supplement No. 4 contained a revision of the map of new shoals near Waugoshance, made necessary by the discovery of a third new shoal.

Bulletin 13, the first bulletin prepared entirely in this office, was mailed out in May, 1903. A departure from the form of previous bulletins, which were prepared in five pamphlets each covering one of the Great Lakes, was made by combining the pamphlets into a single book, which form is believed to add much to its usefulness for reference purposes. This publication of 304 pages set forth the latest information obtainable as to channels, harbors, and matters of navigable interest over the entire lakes and connecting waters, and in addition contained small inset charts of the Little Rapids section of St. Marys River in April, 1903, of Arcadia Harbor, Lake Michigan, and of Manistique Harbor, Lake Michigan. Two supplements to this bulletin were also issued prior to the close of the fiscal year, covering all changes received to June 15.

The present circulation of these publications numbers about 1,400 copies, extending to a large proportion of the most important interests engaged in the navigation of the lakes. In addition to this wide distribution there is an increasing demand for the books, arising not only from the navigators themselves but from various outside commercial and industrial concerns and individuals whose interests are related in some measure with lake improvement. Illustrative of this can be cited requests for them received from New York, New Jersey, Iowa, Wyoming, and California.

Water levels.—The stages of water in Lakes Superior, Michigan, and Huron have been taken, as heretofore, by gauge readings at Marquette, Milwaukee, and Sand Beach (Harbor Beach), respectively, and the table below shows the monthly means for the year from these records referred to mean tide at New York, levels of 1876, instead of to the "high water of 1838," formerly used, the elevation of which is 604.76 feet for Lake Superior and 584.34 feet for Lakes Huron and Michigan. The stages of Lake Erie at Cleveland are furnished by the United States engineer officer at that place. The elevation of "high water of 1838" for this lake is 575.20 feet above mean tide at New York. The stages of Lake Ontario at Charlotte are furnished by the United States Engineer office at Buffalo. The elevation of "high water of 1838" for this lake is 249.19 feet above mean tide at New York.

Monthly means of water level for stations named, expressed in feet, above mean tide at New York.

[Levels of 1876.]

Station.	1902.						1903.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.
Marquette	602.32	602.33	602.37	602.30	602.53	602.12	601.81	601.63	601.42	601.60	602.01	602.37
Milwaukee	580.40	580.42	580.04	579.89	579.76	579.47	579.25	579.42	579.62	579.89	579.99	580.17
Sand Beach	580.28	580.32	580.07	579.76	579.68	579.45	579.27	579.26	579.42	579.74	579.90	580.05
Cleveland	572.83	572.81	572.47	572.38	572.11	571.91	571.81	571.79	572.37	573.14	573.18	573.14
Charlotte	246.16	246.29	245.90	245.62	245.25	245.03	245.06	245.17	245.76	246.72	246.77	246.68

There is also submitted herewith a sheet showing the monthly mean water levels of all the Great Lakes from January, 1860, to June, 1903, both inclusive.

Investigation of lake levels.—In the prosecution of this subject some very interesting and valuable work has been done in gauging the flow of water in the great open channels forming the connections between the Great Lakes and between them and the Atlantic Ocean.

The discharge observations at the head of Sault Ste. Marie Rapids, taken from the International Bridge, were continued by Junior Engineer W. Edward Wilson until the end of last season, and the results, worked up during the winter, will be found in his report herewith.

The discharge measurements of St. Clair River taken during last season will be found in tabular form in Mr. Russell's report on adjustment of triangulation of St. Clair and Detroit rivers.

It was stated in my last annual report that further investigation of the complicated conditions governing the discharge of St. Clair River would be made, and in the report of Assistant Engineer Thomas Russell, page 2837, following, will be found a least-square discussion of the subject, the resulting formula of which shows a much closer agreement with the empirical formula of last year than was expected.

All the Detroit River discharges measured to date will be found in Mr. Blanchard's report, following.

No discharges of the Niagara River were taken during this year, and the latest information available will be found in the Annual Report of the Chief of Engineers for 1900, pages 5326 to 5361.

No discharge work was done on the St. Lawrence River during the past year, and the results of the previous work done there will be found in the Annual Report of the Chief of Engineers for 1902, pages 2779 to 2811.

The following table gives a summary of discharges, as so far determined, corresponding to the mean elevations of the various lakes for the last forty-two years:

Table of mean discharges.

Mean elevation for 42 years (1860-1901) above mean tide at New York City.		Corresponding mean discharge, in cubic feet per second.	
Lake.	Stage.	River.	Discharge.
Superior	601.53	St. Marys	73,000
Huron	581.05	St. Clair	220,000
Erie	572.73	Detroit	222,000
		Niagara	227,800
Ontario	246.29	St. Lawrence	256,700

In the report, herewith, of Principal Assistant Engineer E. E. Haskell will be found an interesting summary of the season's work of the various field parties which have been under his immediate supervision and of the reduction of their work, the details of which will be found in the reports, also herewith, of Assistant Engineers F. C. Shenehon and Thomas Russell and Junior Engineers F. G. Ray, Murray Blanchard, W. Edward Wilson, and A. H. Horton.

For the continuation of the work of investigating lake levels not less than $10,000 should be provided for next year.

A matter of greater immediate importance to the commercial interests of the Great Lakes is the bringing up to date of the existing Lake Survey charts, their issue in colors, and the extension of the series to completion on a comprehensive plan.

The original charts were prepared with reference to a navigation calling for a draft of only 12 feet. The soundings were referred to planes representing a mean or average stage of water, and general depths exceeding 18 feet below such planes were not closely developed; but present conditions of commerce demand that the bottom be now accurately charted to depths of not less than 30 feet in the open lakes, or 25 feet in their connecting rivers or straits, and these depths should relate to "low-water" stages instead of to the "mean stage" referred to above. This will call for extensive surveys and a vast amount of office work, all of which must be done with great care and accuracy. This work has been inaugurated with a considerable force, and means should be supplied to carry it to completion as rapidly as possible. An expenditure of $140,000 during the year ending June 30, 1905, will be necessary for such reasonable progress as the circumstances of the case require.

I therefore recommend and, so far as permissible, urge that the appropriation for the year 1905 be made to cover the two amounts above indicated, as follows:

For survey of Northern and Northwestern Lakes, including all necessary expenses for preparing, correcting, extending, printing, and issuing charts and bulletins, and of investigating lake levels, with a view to their regulation, to be immediately available and to remain available until expended, one hundred and fifty thousand dollars.

Money statement.

July 1, 1902, balance unexpended		$174,109.89
Amount allotted from sundry civil act approved March 3, 1903		145,000.00
		319,109.89
June 30, 1903, amount withdrawn during fiscal year	$10,038.71	
June 30, 1903, amount expended during fiscal year	136,634.46	
		146,673.17
July 1, 1903, balance unexpended		172,436.72
July 1, 1903, outstanding liabilities		13,810.40
July 1, 1903, balance available		158,626.32
July 1, 1903, amount covered by uncompleted contracts		6,527.65
Amount that can be profitably expended in fiscal year ending June 30, 1905, in addition to the balance unexpended July 1, 1903		150,000.00

Dates and amounts of appropriations for surveys of Northern and Northwestern Lakes.

March 3, 1841	$15,000	March 2, 1868	$77,500
March 18, 1842	20,000	July 20, 1868	75,000
March 1, 1843	30,000	March 3, 1869	100,000
June 17, 1844	20,000	July 15, 1870	100,000
March 3, 1845	20,000	March 3, 1871	175,000
August 8, 1846	25,000	June 10, 1872	175,000
August 12, 1848	25,000	March 3, 1873	175,000
March 3, 1849	10,000	June 23, 1874	175,000
September 28, 1850	25,000	March 3, 1875	150,000
March 3, 1851	25,000	July 31, 1876 (not including $16,000 applied to survey of Mississippi River)	84,000
August 30, 1852	25,000		
March 3, 1853	50,000		
August 5, 1854	50,000	March 3, 1877 (not including $25,000 applied to survey of Mississippi River and including $9,500 received from sale of steamers)	94,500
March 3, 1855	50,000		
August 30, 1856	50,000		
March 3, 1857	50,000		
June 12, 1858	75,000		
March 3, 1859	75,000	June 20, 1878 (not including $49,500 applied to survey of Mississippi River)	49,500
June 21, 1860	75,000		
March 2, 1861	75,000		
July 5, 1862	105,000	March 3, 1879	85,000
February 9, 1863	106,879	June 16, 1880	40,000
July 2, 1864	100,000	March 3, 1881	18,000
February 28, 1865	125,000	August 7, 1882	12,000
June 12, 1866	50,000		
March 2, 1867	77,500	Total	2,939,879

Printing and issue of charts for use of navigators and electrotyping copperplates for chart printing.

March 3, 1883	$3,000	March 3, 1893	$2,000
July 7, 1884	3,000	August 18, 1894	2,000
March 3, 1885	3,000	March 2, 1895	2,000
August 4, 1886	2,000	June 11, 1896	2,000
March 3, 1887	2,000	June 4, 1897	2,000
October 2, 1888	2,000	July 1, 1898	3,000
March 2, 1889	2,000	March 3, 1899	3,000
August 30, 1890	2,000	June 6, 1900	3,000
March 3, 1891	2,000		
August 5, 1892	2,000	Total	42,000

Surveys and additions to and correcting engraved plates.

March 2, 1889	$5,000	June 11, 1896	$25,000
August 30, 1890	10,000	June 4, 1897	25,000
March 3, 1891	10,000	July 1, 1898	25,000
August 5, 1892	5,000	March 3, 1899	25,000
March 3, 1893	25,000		
August 18, 1894	25,000	Total	205,000
March 2, 1895	25,000		

Surveys, including investigations of lake levels, correcting, printing, and issuing charts and bulletins.

June 6, 1900	$75,000	March 3, 1903	$150,000
March 3, 1901	100,000		
June 28, 1902	150,000	Total	475,000

REPORT OF MR. E. E. HASKELL, PRINCIPAL ASSISTANT ENGINEER.

OFFICE SURVEY OF NORTHERN AND NORTHWESTERN LAKES,
Detroit, Mich., July 27, 1903.

MAJOR: I have the honor to submit the following report of progress upon work pertaining to the survey of northern and northwestern lakes, including the investigation of lake levels, for the fiscal year ended June 30, 1903.

Your attention is invited to my last annual report, beginning on page 2773 of the Report of the Chief of Engineers for 1902, for a statement showing the condition of the work at the close of that fiscal year.

As heretofore, the work will be reported under the two headings, surveys for corrections to old and the construction of new charts, and the investigation of lake levels.

SURVEYS.

During the year just closed surveys for chart purposes were in progress on the St. Lawrence River, the north end of Lake Michigan, the waters of the Apostle Islands, Lake Superior, Green Bay, Wis., and the west end of Lake Erie. In addition to these surveys, examinations were made of the harbors of Lorain, on Lake Erie, and Oswego and Little Sodus Bay, on Lake Ontario. An examination was also made of parts of the Detroit River and of a part the St. Clair River not touched in the survey of this river two years ago. A portion of the St. Clair River was swept for obstructions.

In addition to the above the survey was engaged in running precise levels between Greenbush and Oswego, N. Y.; Trenton, Mich., and Amherstburg, Ontario; Monroe and Monroe Piers, Michigan; and Algonac and St. Clair Flats Canal, Michigan.

A reconnaissance was made for a system of primary triangulation covering the north end of Lake Huron, for the purpose of connecting the lake survey system at the Straits of Mackinac with the system of the Canadian government in the vicinity of the Duck Islands.

A few magnetic observations were made on Apostle Islands, Lake Superior, and on the St. Lawrence River.

Under miscellaneous work may be mentioned the designs for a sounding machine and a self-registering water gauge, the purchase and equipment of survey steamers, the design of a gas-pipe triangulation station, the building of a new warehouse, and the construction of a new slip and dock at Fort Wayne.

Survey of the St. Lawrence River.—The survey for the revision of the St. Lawrence River charts, which was in progress at the close of the last fiscal year under Asst. Engineer F. C. Shenehon, who has had immediate charge of all work of the survey pertaining to this locality, was continued, and at the close of the field season (the 1st of December) had been completed over the reach of river from Ogdensburg to the head of Wellesley Island, near Clayton, N. Y., a distance of 40 miles.

This survey embraced triangulation, topography, and hydrography. While the work is based upon the old triangulation, quite a number of new stations had to be established to replace lost ones of the old system. Many new tertiary points for control of the topography and hydrography were located. The topography adjacent to both shores and all that was of importance on islands was taken. The hydrography was very detailed and covered all of the channels that were of any importance to the interests of navigation.

The results of this survey are platted on eight detail sheets on a scale of 1:10000. It was decidedly fruitful in new shoals, 32 being discovered. On several known shoals much less water than previously reported was found. One spot shown on the survey charts as having 8 feet was found to have 70 feet. The St. Lawrence has now been carefully resurveyed from St. Regis, the international boundary, to near Clayton, N. Y. This is the most dangerous part of the river within American waters. The remainder of the river to Lake Ontario and a part of the east end of this lake should be resurveyed, but these can wait until other more dangerous localities have been examined.

The details of this work will be found in Mr. Shenehon's report.

Survey of the north end of Lake Michigan.—This work was commenced in June, 1901, and has been prosecuted ever since as diligently as the limited equipment of the survey would permit. It was under the immediate charge of Asst. Engineer L. C. Sabin from its inception until January of the present year, when Mr. Sabin was transferred to the United States engineer office of Detroit, Mich.

The work of the past year was confined to the vicinity of the Beaver Island passage and consisted of triangulation and hydrography. The former was necessary for properly controlling the latter, as no trace of the old triangulation of this locality was to be found.

The triangulation was begun June 14, 1902, by a small party in charge of Junior Engineer W. J. Graves, working under the direction of Mr. Sabin. This party was quartered in a camp and made use of a sailboat for means of transportation. This triangulation starts from the primary line—work of 1896—Mackinac Island-west base, in the Straits of Mackinac, and proceeds to the westward. It was projected to cover the entire group of the Beaver Islands for the purpose of controlling the hydrography of the area to the north of the islands and the passage to the eastward of them. This work was also planned with a view to its extension to the southward, as such extension may be necessary in the future. During the season of 1902 enough of this triangulation was completed to care for the hydrography executed. The results of it will be published at a future date, when the whole work of the locality can be made the subject of one report.

When the season of 1902 opened the survey was without a boat for carrying on this work. Through the courtesy of Capt. Charles Keller, Corps of Engineers, U. S. Army, the tug *Colonel Graham*, of the Grand Rapids district, was secured, and she arrived at Detroit June 16, 1902. The boat was immediately overhauled, provided with the necessary outfit for the work, and turned over to Mr. Sabin on July 11.

The interval between July 14 and August 2 was spent in sweeping in St. Clair River. Immediately on completion of this work Mr. Sabin proceeded to the north end of Lake Michigan with the tug and commenced the hydrography in the vicinity of the Beaver Island Passage. An area about 4 miles in extent north and south by 8 miles east and west, lying centrally immediately north of Waugoshance lighthouse, was sounded in detail with one of the new sounding machines, with good results. Three new shoals, dangerous to a 20-foot navigation, were found within this area.

An area of about 4 miles' extent north and south by 3 miles east and west, between Grays Reef light-ship and Waugoshance light-house, covering the Vienna and Middle shoals, was likewise sounded in detail, giving in a number of instances shoaler water than shown on the charts. St. Helena shoal was also sounded and found to be considerably larger east and west than shown by previous surveys.

The field work of this party closed November 16, after having obtained a total of 51,200 soundings. The outfit was brought to Detroit and the tug laid up for the winter.

Field work of the triangulation for the season of 1903 of this locality was opened May 16 by a small party under the immediate charge of Junior Engineer M. S. MacDiarmid. A short time was spent in reconnaissance on Beaver Island and on the mainland south of Cross Village, with the result of finding good locations for stations which will readily permit of extending this system to the southward. By the end of the fiscal year Mr. MacDiarmid had built four of the nine stations remaining to complete the work in the immediate locality.

During the winter the completed triangulation was reduced and soundings platted on three large sheets on a scale of 1:10000.

Survey of the waters of the Apostle Islands.—This work was under the direction of Junior Engineer F. G. Ray, who has had charge of the field operations in this locality since the commencement of the work in the spring of 1901. This survey consisted of triangulation, topography, and hydrography.

During the season of 1902, the secondary triangulation reported a year ago was extended to the northward, eastward, and westward, covering the entire group of the Apostle Islands, and connected with the old primary station Detour. (For a sketch of

this triangulation see Plate I, of Mr. Ray's report.) The stations of this work have been referred to the new standard, and so are in harmony with the newly adjusted triangulation net of the Survey. They are all permanently marked, making them available for future work, should such prove necessary.

Topography to the extent of securing new shore line of all the islands not reported last year, and of the mainland from Red Cliff Point to Sand Point, 96 miles in all, was taken.

The hydrography was detailed and covered not only the channels between the islands, but a large area to the north of the group. A new shoal, with but 17½ feet of water on it—when referred to the Lake Superior standard low-water plane of 600 feet—was found seven-eighths of a mile N. 25° E. of the most northerly point of Oak Island. The Bear Island shoal was found to be about three-eighths of a mile north by west of the charted position, with a minimum depth of 13 feet instead of 16 feet, when referred to standard low water. Devils Island shoal was found to have 4 feet less water than previously reported. During the season 39,345 soundings were taken, of which 15,030 were located by transits or sextants.

The Apostle Islands survey was completed October 15, 1902, after spending less than two full seasons on the work. The topography and hydrography are platted on a scale of 1:10000 on 23 detail sheets. The results of this work certainly justify the expenditure. There is no longer any uncertainty as to this locality.

Mr. Ray, en route to Detroit with his party, made an examination of 15 square miles of water lying along the sailing course between Point Iroquois and Whitefish Point, abreast of the southerly end of Parisian Island, Lake Superior. Nothing but deep water could be found, and it is more than probable that vessels which have reported striking in this locality have been too near the island.

Mr. Ray also made an examination in Lake Huron of a shoal off Alcona, Mich., and of the shoal water lying along the shore between Point Au Sable and Au Sable, Mich. He arrived in Detroit November 29, where the party disbanded and the steamer *Search* was laid up for the winter.

Mr. Ray's report follows, in which will be found the results of his work more in detail.

Survey of the northerly end of Green Bay.—Mr. Ray and party, with the steamer *Search*, left Detroit May 16, 1903, for inaugurating a survey of the northerly end of Green Bay and the entrance to it. Triangulation, topography, and hydrography are necessary in this locality. At the end of the fiscal year this work was well in hand and good progress being made.

On June 18, Mr. Ray was directed to temporarily suspend work in Green Bay and proceed to Racine, Wis., and survey the new shoal lying 1.68 miles N. 66° E. of Wind Point light-house, found by the steamer *Saranac*, striking it on April 16, 1903. This shoal has a least depth of 17.6 feet when Lake Michigan is at the elevation of its standard low-water reference plane of 578 feet. While examining this locality, Mr. Ray found a second shoal lying 1.24 miles S. 55° E. of Wind Point light-house, with least depth of 17.3 feet referred to standard low water. Racine reef was also carefully examined and appears to be considerably larger than shown by the surveys of 1867 and 1873. It has undoubtedly been building up. Mr. Ray returned to his regular work in Green Bay July 13, 1903.

Survey of the west end of Lake Erie.—This work is under the immediate charge of Assist. Engineer F. C. Shenehon, and was inaugurated June 26, 1903, with the survey steamer *General Williams.*

Examination of harbors, etc.—At the close of the last fiscal year Draftsman Andrew J. Swift was engaged in making an examination of Lorain Harbor, on Lake Erie. He completed it and returned to Detroit July 9, 1902. He also made an examination of Oswego Harbor and Little Sodus Bay, on Lake Ontario, between November 27 and December 13, 1902.

During the season of 1902 Junior Engineer Murray Blanchard made a stadia survey of portions of the dock lines of Detroit and Windsor for changes that had taken place. He also made a stadia survey during the latter part of June, 1903, of that portion of Herson Island, St. Clair River, lying back from the shore of the South channel.

All of the critical areas of the American side of the St. Clair River, from Marysville to St. Clair, were swept with the new sweep, by Assist. Engineer L. C. Sabin, between July 14 and August 2, 1902.

In regard to the new sweep, the failure of the contractors to complete it on time deprived the Survey of much of the use of it that it expected to make. The contract for it was let February 6, and it was to be completed April 30, 1902. It was not delivered until July 14, a date too late to take it to the Lake Michigan work for the short season remaining. After the sweeping above described, it was loaned to Maj. W. H.

Bixby, Corps of Engineers, U. S. Army, who had many critical areas of the St. Clair River below St. Clair swept with it.

The sweep has proved very satisfactory indeed. As in all new designs, experience in the use of it has suggested a few improvements that it is hoped to effect in the near future.

Precise levels.—At the close of the last fiscal year a precise level party, in charge of Junior Engineer A. H. Horton, was in the field and began the new line of levels between Greenbush and Oswego, N. Y., July 1, 1902. Mr. Horton completed this line November 15, after having run 206.1 miles of double line, or an average of 45.8 miles of completed line per month. This is a good record and the results show a high grade of work. Mr. Horton's report follows, and will be found to contain much of interest. The method adopted by the survey of testing the lengths of its precise level rods has proved very satisfactory and clearly demonstrates what happens to wooden rods in use in the field.

Mr. Horton severed his connection with the survey May 1, 1903, to accept a position with the United States Geological Survey. It was with regret that we lost him.

The above line, together with a new line between Dobbs Ferry and Greenbush, N. Y., run by the United States Coast and Geodetic Survey in the early summer of 1902, the results of which were furnished this Office, gave a new sea-level connection. This connection, together with the precise levels and water levels collected by this Office during the past few years, completed the data necessary for a complete readjustment of all the Survey levels. This adjustment was made during the winter with very satisfactory results. These new data were furnished the United States Coast and Geodetic Survey, who generously undertook and carried out a second adjustment of the Government levels east of the Mississippi River. For this good work they are deserving of special commendation. Through their efforts we can now present a system of lake survey levels that is consistent throughout and that is in harmony with all of the Government levels east of the Mississippi River. The lake survey bench marks, with their old and new elevations, have been tabulated, and will be found appended to this report in Table No. 1. Detailed descriptions of all of these bench marks have been carefully prepared and follow the table.

During June, 1903, Junior Engineer W. Edward Wilson ran three short lines of precise levels, as follows: A line from Trenton, Mich., to Amherstburg, Ontario, to connect with the United States engineer water gauge at Amherstburg, a distance of 7 miles. A line from Monroe, Mich., to Monroe light-house, to connect with a water gauge at the latter point, a distance of 4 miles. A line from Algonac, Mich., to St. Clair Flats Canal, for the purpose of connecting with the water gauge at the canal, a distance of 12 miles. The results of these levels will be found in Table No. 1.

Triangulation, north end of Lake Huron.—In order to more accurately locate the position of the southerly shore of Cockburn and Manitoulin islands, and also the position of the Duck Islands, a system of primary triangulation was projected, starting from the primary line Mackinac Island–Robinson of the Lake Survey triangulation at Straits of Mackinac. This system will cover the northerly end of Lake Huron and make a junction with the triangulation of the Canadian government, ending at Cockburn Island.

Junior Engineer H. F. Johnson took the field July 9, and on October 26, 1902, completed a reconnaissance for a very satisfactory system of 12 stations that will cover the area described and that will reach as far south as Alpena, Mich.

Mr. Johnson took the field for the station building and angle reading of this system May 23, 1903, and by the close of the fiscal year had built one 10-foot wooden station and erected one 108-foot gas-pipe station, which will be described later. The details of this work will be given in future reports, when results can be submitted.

Magnetics.—Observations for magnetic declination during the year were few, owing to the fact that we had no assistant who could be spared for this work. The only observations taken with a magnetometer were those by Mr. Ray at the Apostle Islands, Lake Superior. These will be found in Mr. Ray's report and will be seen to be very satisfactory. The magnetic declination of points in the St. Lawrence River survey was obtained with a transit by Mr. Shenehon and will be found on the detail sheets.

Water levels.—For a record of the stage of water in the lakes and their connecting waters, the survey maintained the usual series of water gauges. A new self-registering gauge was established at Marquette, Mich., in October, 1902. The self-registering gauge at Detour, Mich., was discontinued in May, 1903, the level connection having been completed, and was taken to Escanaba, Mich., where it will shortly be established. There are still two self-registering gauges to be established—namely, at Milwaukee, Wis., and Cleveland, Ohio—to complete the series originally contemplated.

All of the gauge records up to May 1, 1903, were reduced, and as soon as they can

be adjusted to the new levels will be ready for publication. They will appear in our next annual report.

Miscellaneous.—During the fiscal year 1902 the subject of a special sounding machine for the hydrographic work was taken up and a design completed by Asst. Engineer L. C. Sabin, assisted by Junior Engineer W. J. Graves. One of these machines, shown in position on the tug *Colonel Graham*, on accompanying Plate No. 1, was given a good trial last season and proved so satisfactory that during the winter three more were made, and each of the survey steamers is now equipped with one.

A detailed description of the machine is hardly necessary. The principle is the heavy fish-shaped cast-iron weight of 100 pounds, suspended by a No. 30 piano wire, which has been used by the survey for some time, and with the proper mechanism for handling the weight rapidly, to which is attached a scale for indicating depths. In sounding, at the commencement of a line the sounding weight is lowered until the bottom of it is even with the water surface; the scale pointer is then set to read zero; the weight is lowered until it touches bottom, the scale read, and the weight hoisted 2 to 3 feet and carried to the position of the next sounding, when it is again lowered and the scale read; the deflection scale is also read, which gives the deflection of the sounding wire from the vertical, hence the correction to the sounding. For depths less than 30 feet and a speed of the sounding boat not exceeding 4 miles per hour this correction is insignificant.

By this method no shoal water is skipped between soundings, depths are more accurately measured than with the lead and line, and the leadsman does not get wet. Sounding weights are occasionally lost, but are not expensive.

New self-registering water gauge.—In the past, in connection with the investigation of lake levels, the office has had occasion to employ quite a number of gauge readers for reading water gauges. The records have not always been satisfactory, mainly owing to their lack of continuity. A consideration of the subject showed that a decided saving in money could be made and a continuous record obtained by making use of suitable self-registering gauges. None entirely satisfactory were to be found in the market. The question of producing a suitable design was assigned to Junior Engineer W. Edward Wilson, who, with the criticism of a number of survey assistants, produced a very satisfactory instrument.

The principal features of the instrument are that it records on a large scale, namely, 2 inches to the hour and 3 inches to the foot; it is compact, occupying less than 1 cubic foot of space; it can be set up on a dock and housed under a storm-proof box. It is not intended to take the place of the larger self-registering gauges of the survey; it requires more attention than they do and should be visited daily. Seven of these have been in operation for a short time, with very satisfactory results.

Survey steamers.—One of the important features of the year's work was the purchase, remodeling, and equipping of two steamers for survey work.

The *General Williams* was purchased from the United States engineer office of Grand Rapids, Mich., October 1, 1902. She was immediately brought to Detroit, docked, and given all needed repairs to both hull and machinery. During the winter and spring she was remodeled so as to make accommodations for more people and provided with a steam windlass and stockless anchors. As refitted the boat makes a fine survey steamer, with accommodations for 6 engineers and a crew of 18. This work was greatly delayed by the failure of the company furnishing the windlass to deliver it on time, and in consequence the boat was not ready to take the field until late in June.

A second steamer, the *Lorain L.*, was purchased from Mr. George T. Arnold, of Mackinac Island, Michigan, and was delivered in Detroit on March 27, 1903. She was what would be called a day passenger boat, and for the survey work had to be provided with living quarters for both officers and crew and with a suitable anchoring outfit. This work was immediately undertaken, and on July 21 the boat left Detroit for duty in the north end of Lake Michigan, under her new name, the *Surveyor*.

All of the work of remodeling both steamers was carried on by hired labor and proved quite an undertaking on account of the heavy volume of regular work. The results, however, were very satisfactory, and the Lake Survey is now well equipped for survey work. It has three steamers, the *Search*, *General Williams*, and *Surveyor*, which are capable of taking care of all work of the survey, whether off or in shore. In addition it has two small tugs, *U. S. L. S. Nos. 1* and *2*, of which the former is well suited for river and harbor surveys and is now engaged on such work. The latter is no longer serviceable without extensive repairs and has been hauled out for safe-keeping of machinery, as she is not needed for work at present.

Gas-pipe triangulation station.—The lack of suitable timber, coupled with its high cost, has made the construction of tall triangulation stations expensive. To reduce

this expense in the triangulation of the north end of Lake Huron, where several high stations are required, the survey took up the consideration of the use of gas pipe, with the idea of constructing stations that could be readily moved from place to place. Accordingly, this subject was assigned to Junior Engineer H. F. Johnson, who made a careful study of the problem and submitted a design with a report, showing clearly that the construction of such stations would be in the interests of economy. Six of these stations have been purchased, and by the close of the fiscal year one of them had been erected.

A complete station consists of two towers—tripod and platform—which are square in plan. It is 108 feet high, being made of six 18-foot sections. A station any multiple of 18 feet in height can be erected by taking the top sections of a complete station. Further details of these stations will be given in a future report when we have had more experience with them.

Warehouse, slip and dock.—During the fiscal year specifications were prepared for a new warehouse and a new slip and dock at Fort Wayne. The contract for the warehouse was let to Mr. Max Bartholomaei, the lowest bidder, September 25, 1902. The building was completed March 2, three months after the expiration of the contract.

The contract for dredging the slip was let to the Detroit Dredging Company, Limited, the lowest bidder, August 19, and was completed August 28, 1902.

The contract for the piling and sheet piling of the slip and dock was let to Mr. M. J. Griffin, the lowest bidder, September 4, 1902, and at this writing, eight months after expiration of contract, is about completed. Mr. Griffin was greatly delayed by difficulty of securing delivery of material.

The warehouse is a substantial brick building 25 by 50 feet in plan, and 1½ stories high. It has an iron cornice, slate roof, iron shutters for windows, and iron doors.

The slip is 80 by 260 feet in size, with an average depth of 15 feet. The dock incloses the old one that was tumbling down and has a river face of 70 feet.

The survey now has good headquarters for its steamers, where they can be wintered, repaired, and fitted out, and a warehouse for the proper storage of instruments and general property.

Office work.—The office work of the survey force has been the reduction of the notes gathered during the year and of accumulated data.

Asst. Engineer Thomas Russell made an adjustment of the old Detroit River and the new St. Clair River triangulation, and reduced all of it to the new United States standard datum. A report by Mr. Russell, giving the results of this adjustment follows. To this report Mr. Russell has appended the reduced discharges of the St. Clair River, made during the season of 1902.

Mr. Russell also made an index of all the astronomic and geodetic stations of the survey for convenience of reference, and this index will be found appended to this report. See page 2745.

INVESTIGATION OF LAKE LEVELS.

Under the investigation of lake levels, discharge measurements were in progress on the Detroit River, the St. Clair River, and the St. Marys River. Slope observations of the Niagara River from Lake Erie to the Falls were commenced in June of 1903.

Discharge of the Detroit River.—At the beginning of the fiscal year a discharge party under the direction of Junior Engineer Murray Blanchard was in the field, measuring the discharge of the Detroit River at the Fort Wayne section. This work was continued until the 20th of November, with the exception of an interruption of six weeks spent in St. Clair River measurements, as described below, when this party was disbanded for the season. Within this period 57 discharge measurements were made.

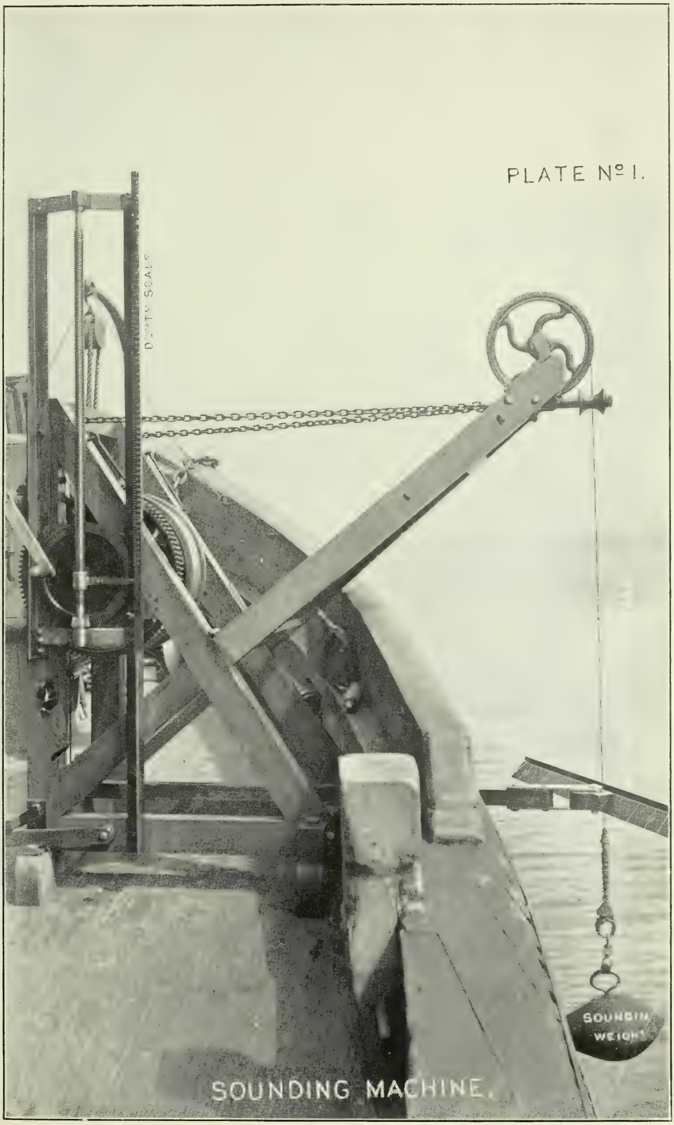
Up to date we have a total of 117 measurements, with a range in the stage of Lake St. Clair of 1.6 feet, and in the stage of Lake Erie of 2.5 feet. These discharges have been reduced and will be found, with related gauge data, in Table No. 6 of Mr. Blanchard's report, which follows.

In my last annual report I pointed out some of the complications governing the flow of this stream. During the year quite a study was made of the data collected, in the hope of deriving a satisfactory equation expressing the flow in terms of the stage of water in lakes Erie, St. Clair, and Huron; but as yet none has been found satisfactorily fulfilling all conditions. It is our intention to continue this study as time permits, contenting ourselves for the present by giving the actual observed quantities.

In connection with the discharge measurements of both 1901 and 1902, the temperature of the surface water in midstream was observed. These are of interest and are shown graphically on plate No. 2.

Discharge of the St. Clair River.—The discharge of the St. Clair River was measured at section dry dock, Port Huron, by Junior Engineer Murray Blanchard, from August 8 to October 1, 1902, the period of interruption in the Detroit River measure-

PLATE No. 1.



SOUNDING MACHINE.

ments above noted. During this interval forty-eight measurements were made, the reduction of which was started by Asst. Engineer L. C. Sabin, and, after his departure, was completed by Asst. Engineer Thomas Russell. The results will be found appended to Mr. Russell's report on adjustment of triangulation of Detroit and St. Clair Rivers.

These discharges, together with all of those previously measured at section dry dock, have been made the subject of a special discussion by Mr. Russell on the flow of the St. Clair River with gratifying results. The close agreement between Mr. Russell's equation derived for the flow of the St. Clair and that of Mr. Sabin's, given in his last annual report, is of interest. It is rather surprising that the empirical method gave so close a result. Mr. Russell's report follows, and is an excellent discussion of the problem.

Discharge of the St. Marys River.—Discharge measurements of the St. Marys River were in progress from the International Bridge, Sault Ste. Marie, Mich., from July 17 until November 13, 1902. This work was in charge of Junior Engineer W. Edward Wilson, and during the period named a total of 149 discharges were measured. This work was reduced during the winter by Mr. Wilson, and the results will be found in his report.

The determination of the volume of flow of the St. Marys River has been an intricate problem, owing to the many artificial changes that have been made in the channel in the vicinity of the discharge section. The progressive work of the survey from year to year has gradually eliminated the unknown factors which have appeared in the course of the work, and it is thought that the results given in Mr. Wilson's report are very complete and very satisfactory

Slope observations of the Niagara River.—The distribution of the slope of the Niagara River from Lake Erie to Niagara Falls has been more or less uncertain. In order to clear up this question, Junior Engineer W. Edward Wilson took the field June 25, 1903, equipped with self-registering gauges which have been set up at critical points between the Lake and the Falls. These gauges will be maintained for the remainder of the season, at least, and will be connected with the bench marks of the survey's precise level line along the river, thus reducing the work to a certainty.

General results.—In regard to the investigation of lake levels in general, the survey now has a very complete determination of the discharge of all the lake outlets—the St. Lawrence, Niagara, Detroit, St. Clair, and St. Marys rivers—for the stages of water which have prevailed since 1898. Further, it has completed an adjustment of all of its levels and is now in a position to start a discussion of the physics of the Great Lakes, something that heretofore has been impossible on an intelligent basis owing to the lack of data.

To aid in the discussion of the question of evaporation, data relative to lake temperatures is needed. This phase of the subject will receive careful attention during the coming year.

The reports of assistants who were in charge of work during the year follow, and in closing this report I wish to thank them and their assistants for their earnest efforts to make the year's work satisfactory in both quality and quantity.

Very respectfully, your obedient servant,

E. E. Haskell,
Principal Assistant Engineer.

Maj. W. L. Fisk,
Corps of Engineers, U. S. Army.

Table No. 1 contains the old and new elevations in feet of all the permanent bench marks established or connected with by precise levels of the United States lake survey based on the Coast and Geodetic Survey adjustment of 1903.

These comprise twelve groups: Albany, N. Y. (Greenbush), to Oswego, N. Y.; International boundary to Cape Vincent, N. Y., along St. Lawrence River; bench marks on Canadian locks; Olcott, N. Y., to Buffalo, N. Y.; Gibraltar, Mich., to Lexington, Mich.; Detour, Mich., to Point Iroquois on Lake Superior, along St. Marys River; Escanaba, Mich., to Marquette, Mich.; bench marks established directly by water levels along lakes; Gibraltar, Mich., to Toledo, Ohio; Trenton, Mich., to Amherstburg, Ontario; Monroe, Mich., to Monroe light-house; and Algonac, Mich., to St. Clair Flats Canal lower light-house.

TABLE No. 1.

Place.	Designation of bench mark.	Old elevation.	New elevation.
		Feet.	*Feet.*
At Rensselaer, N. Y	P. B. M. Greenbush	14.730	13.863
Do	P. B. M. No. 1		13.918
Do	P. B. M. No. 2		26.162
Do	P. B. M. No. 3		21.333
At East Albany, N. Y	P. B. M. No. 4	27.018	26.273
At Albany, N. Y	P. B. M. No. 5	17.592	16.824
Do	P. B. M. No. 6		26.205
North of Albany, N. Y	P. B. M. No. 7		30.041
At Watervliet, N. Y	P. B. M. No. 8		25.724
North of Watervliet, N. Y	P. B. M. No. 9	49.693	49.002
At Cohoes, N. Y	P. B. M. No. 10	70.430	69.724
Do	P. B. M. No. 11	160.492	159.810
Do	P. B. M. No. 12	191.716	190.077
North of Cohoes, N. Y	P. B. M. No. 13		192.291
At Crescent, N. Y	P. B. M. No. 14		194.618
East of Vischers Ferry, N. Y	P. B. M. No. 15		193.033
Do	P. B. M. No. 16		192.300
Do	P. B. M. No. 17		190.750
Do	P. B. M. No. 18		190.870
At Vischers Ferry, N. Y	P. B. M. No. 19		203.275
At Fondas Basin, N. Y	P. B. M. No. 20		212.264
At Rexford, N. Y	P. B. M. No. 21		221.521
Do	P. B. M. No. 22		231.431
West of Rexford, N. Y	P. B. M. No. 23		231.324
East of Schenectady, N. Y	P. B. M. No. 24		234.900
At Schenectady, N. Y	P. B. M. No. 25		235.129
Do	P. B. M. No. 26		232.935
Do	P. B. M. No. 27		232.936
West of Schenectady, N. Y	P. B. M. No. 28		235.043
Do	P. B. M. No. 29		239.596
Do	P. B. M. No. 30		242.647
Do	P. B. M. No. 31		253.629
East of Pattersonville, N. Y	P. B. M. No. 32	251.459	250.949
Do	P. B. M. No. 33		258.275
At Pattersonville, N. Y	P. B. M. No. 34		259.122
West of Pattersonville, N. Y	P. B. M. No. 35		259.261
East of Amsterdam, N. Y	P. B. M. No. 36		258.492
Do	P. B. M. No. 37	264.228	263.662
Do	P. B. M. No. 38		263.736
Do	P. B. M. No. 39		271.680
At Amsterdam, N. Y	P. B. M. No. 40		279.424
Do	P. B. M. No. 41		276.542
Do	P. B. M. No. 42		263.649
West of Amsterdam, N. Y	P. B. M. No. 43	280.434	279.927
East of Port Hunter, N. Y	P. B. M. No. 44		282.455
At Port Hunter, N. Y	P. B. M. No. 45		297.899
East of Fultonville, N. Y	P. B. M. No. 46		300.297
Do	P. B. M. No. 47		298.474
At Fultonville, N. Y	P. B. M. No. 48		302.048
West of Fultonville, N. Y	P. B. M. No. 49		299.934
Do	P. B. M. No. 50		299.386
Do	P. B. M. No. 51		297.068
West of Downing, N. Y	P. B. M. No. 52		297.241
East of Sprakers, N. Y	P. B. M. No. 53		298.899
At Sprakers, N. Y	P. B. M. No. 54		303.825
Do	P. B. M. No. 55	305.864	305.323
At Canajoharie, N. Y	P. B. M. No. 56		308.146
Do	P. B. M. No. 57	307.011	306.461
East of Fort Plain, N. Y	P. B. M. No. 58		307.402
Do	P. B. M. No. 59		312.151
At Fort Plain, N. Y	P. B. M. No. 60		314.236
West of Fort Plain, N. Y	P. B. M. No. 61		313.729
East of St. Johnsville, N. Y	P. B. M. No. 62		313.022
Do	P. B. M. No. 63	320.002	319.386
At St. Johnsville, N. Y	P. B. M. No. 64		320.558
West of Mindenville, N. Y	P. B. M. No. 65		325.653
Do	P. B. M. No. 66	328.756	328.162
Indian Castle, N. Y	P. B. M. No. 67		334.925
West of Indian Castle, N. Y	P. B. M. No. 68		336.821
At Little Falls, N. Y	P. B. M. No. 69	343.967	343.487
Do	P. B. M. No. 70		353.527
Do	P. B. M. No. 71		363.160
Do	P. B. M. No. 72		373.208
West of Little Falls, N. Y	P. B. M. No. 73	378.770	378.267
Do	P. B. M. No. 74		381.081
Do	P. B. M. No. 75		389.170
East of Herkimer, N. Y	P. B. M. No. 76	394.031	393.325
At Herkimer, N. Y	P. B. M. No. 77		394.492
At Mohawk, N. Y	P. B. M. No. 78		393.129
West of Mohawk, N. Y	P. B. M. No. 79		398.412
Do	P. B. M. No. 80		407.998
At Ilion, N. Y	P. B. M. No. 81		409.288

TABLE No. 1—Continued.

Place	Designation of bench mark.	Old elevation.	New elevation.
		Feet.	*Feet.*
At Ilion, N. Y	P. B. M. No. 82		408.547
West of Ilion, N. Y	P. B. M. No. 83		417.453
At Frankfort, N. Y	P. B. M. No. 84		427.326
Do	P. B. M. No. 85	419.242	418.713
West of Frankfort, N. Y	P. B. M. No. 86		432.339
East of Utica, N. Y	P. B. M. No. 87		427.678
Do	P. B. M. No. 88		431.332
At Utica, N. Y	P. B. M. No. 89		431.537
Do	P. B. M. No. 90		427.712
Do	P. B. M. No. 91		423.787
Do	P. B. M. No. 92		430.410
West of Utica, N. Y	P. B. M. No. 93		435.710
At Whitesboro, N. Y	P. B. M. No. 94		433.688
Do	P. B. M. No. 95		434.967
East of Oriskany, N. Y	P. B. M. No. 96		436.553
At Oriskany, N. Y	P. B. M. No. 97		433.960
West of Oriskany, N. Y	P. B. M. No. 98		435.793
Do	P. B. M. No. 99		433.106
At Stanwix, N. Y	P. B. M. No. 100		437.626
At Rome, N. Y	P. B. M. No. 101		433.505
Do	P. B. M. No. 102		436.090
West of Rome, N. Y	P. B. M. No. 103		435.266
Do	P. B. M. No. 104		433.124
Do	P. B. M. No. 105		435.391
At New London, N. Y	P. B. M. No. 106		435.338
At Stacys Basin, N. Y	P. B. M. No. 107		435.646
Do	P. B. M. No. 108	432.878	433.868
East of Higginsville, N. Y	P. B. M. No. 109	131.408	431.050
At Higginsville, N. Y	P. B. M. No. 110		433.274
West of Higginsville, N. Y	P. B. M. No. 111		375.277
At Sylvan Junction, N. Y	P. B. M. No. 112		377.016
At North Bay, N. Y	P. B. M. No. 113		387.214
West of North Bay, N. Y	P. B. M. No. 114		422.119
At Cleveland, N. Y	P. B. M. No. 115		394.763
Do	P. B. M. No. 116		423.007
At Bernhardts Bay, N. Y	P. B. M. No. 117		386.625
At Constantia, N. Y	P. B. M. No. 118		393.675
West of Constantia, N. Y	P. B. M. No 119		410.716
At West Monroe, N. Y	P. B. M. No. 120		395.101
At Central Square, N. Y	P. B. M. No. 121		453.975
West of Caughdenoy, N. Y	P. B. M. No. 122		380.732
At Pennellville, N Y	P. B. M. No. 123		412.468
Southeast of Fulton, N. Y	P. B. M. No. 124		399.841
At Fulton, N. Y	P. B. M. No. 125		347.947
Do	P. B. M. No. 126		329.025
Do	P. B. M. No. 127		323.167
Do	P. B. M. No. 128		322.472
North of Fulton, N. Y	P. B. M. No. 129		320.182
Do	P. B. M. No. 130		312.008
At Minetto, N. Y	P. B. M. No. 131		301.231
North of Minetto, N. Y	P. B. M. No. 132		291.631
South of Oswego, N. Y	P. B. M. No. 133		286.672
Do	P. B. M. No. 134		271.572
Do	P. B. M. No. 135		274.717
At Oswego, N. Y	P. B. M. No. 136		258.867
Do	P. B. M. No. 137		254.975
Do	P. B. M. No. 138		262.568
Do	P. B. M. No. 139		251.733
Do	P. B. M. "A."	251.964	251 898
Do	P. B. M. "B."	252.477	252.413
Do	P. B. M. "C."	262.040	261.977
At St. Regis, Quebec	P. B. M. A, St. Regis	170.870	169.848
Do	P. B. M. B, St. Regis	167.907	166.884
At Hogansburg, N. Y	P. B. M. P, Hogansburg	179.283	178.260
Do	P. B. M. C, Hogansburg	180.974	179.950
Near Racket River, N. Y	P. B. M. 1	172.905	171.882
Near Grass River, N. Y	P. B. M. 2	209.006	207.982
On River Road, N. Y	P. B. M. 3	205.402	204.378
Do	P. B. M. 4	222.402	221.378
Do	P. B. M. 5	248.382	247.357
At Richards Landing, N. Y	P. B. M. 6	233.406	232.381
At Louisville Landing, N. Y	P. B. M., Louisville Landing	231.035	230.010
Near Louisville Landing, N. Y	P. B. M. 7	225.236	224.211
At Bradfords Hill, N. Y	P. B. M. 8	260.441	259.415
Near Egg Island, N Y	P. B. M. 9	239.852	238.826
Near Murphys Island, N. Y	P. B. M. 10	237.290	236.264
At Waddington, N. Y	P. B. M. 11	279.427	278.401
Do	P. B. M. A, Waddington	273.909	272.883
Do	P. B. M. B, Waddington	277.092	276.065
Near Waddells Point, N. Y	P. B. M. 12	254.323	253.296
At Tilden, N. Y	P. B. M. 13A	274.451	273.423
Do	P. B. M. 13	270.981	269.954

TABLE No. 1—Continued.

Place.	Designatiom of bench mark	Old elevation.	New elevation.
		Feet.	*Feet.*
Near Lisbon, N. Y	P. B. M. 14	274.553	273.525
At Lisbon, N. Y	P. B. M. 15	279.751	278.723
Near Ogdensburg, N. Y	P. B. M. 16	283.259	282.230
At Ogdensburg, N. Y	P. B. M. A, Ogdensburg	278.926	277.897
Do	P. B. M. B, Ogdensburg	281.774	280.745
Do	P. B. M. C, Ogdensburg	290.905	289.877
Do	P. B. M. D, Ogdensburg	252.050	251.022
Near Ogdensburg, N. Y	P. B. M. 17	260.425	259.397
Do	P. B. M. 18	250.076	249.048
Near Morristown, N. Y	P. B. M. 19	250.375	249.346
At Morristown, N. Y	P. B. M. A, Morristown	273.717	272.688
Do	P. B. M. B, Morristown	272.317	271.288
Do	P. B. M. C, Morristown	259.027	257.998
Near Morristown, N. Y	P. B. M. 20	247.765	246.736
Do	P. B. M. 21	344.063	343.033
Near Oak Point Village, N. Y	P. B. M 22	340.262	339.232
Do	P. B. M. O P	339.458	338.427
Do	P. B. M. 23	261.061	260.031
Near Chippewa Village, N. Y	P. B. M. 23A	260.421	259.392
At Chippewa Village, N. Y	P. B. M. C. V	291.729	290.698
Near Chippewa Village, N. Y	P. B. M. 24	291.363	290.332
Do	P. B. M. 25	368.172	367.141
Near Alexandria Bay, N. Y	P. B. M. 26	334.772	333.740
Do	P. B. M. 27	274.565	273.534
At Alexandria Bay, N. Y	P. B. M. A, Alexandria Bay	260.195	259.164
Do	P. B. M. B, Alexandria Bay	285.274	284.243
Near Alexandria Bay, N. Y	P. B. M. 28	289.952	288.920
Do	P. B. M. 29	275.382	274.351
Near Clayton, N. Y	P. B. M. 30	265.248	264.216
At Clayton, N. Y	P. B. M. A, Clayton	279.847	278.815
Do	P. B. M. B, Clayton	265.409	264.376
Do	P. B. M. C, Clayton	261.660	260.628
Near Clayton, N. Y	P. B. M. 31	365.706	364.673
Do	P. B. M. 32	273.902	272.870
Near Dodges Bay, N. Y	P. B. M. 33	260.832	259.799
Near Cape Vincent, N Y	P. B. M. 34	261.326	260.293
At Cape Vincent, N. Y	P. B, M. A, Cape Vincent	255.179	254.146
Do	P. B. M. B, Cape Vincent	260.505	259.472
Do	P. B. M. C, Cape Vincent	273.198	272.165
At Tibbetts Point, N. Y	P. B. M. 35	264.887	263.854
Near Prescott, Ontario	P. B. M. "L"		273.399
At Galops Locks, Ontario	P. B. M., Wier		249 136
Do	P. B. M., Galops		249 219
Do	Zero of gauge, sill of Lock No. 27		234.144
At Morrisburg, Ontario	P. B. M. 1		221.064
Do	P. B. M. "B"		227 125
Do	Zero of gauge, sill of old Lock No. 23		207.773
Do	Zero of gauge, sill of new Lock No. 23		201.715
At Cornwall, Ontario	P. B. M. "A"		167.031
Do	P. B. M. "B"		162.889
Do	P. B. M. "C"		188.284
Do	Zero of gauge, sill of Lock No. 15		143.445
At Olcott, N. Y	P. B. M. No. 4		259.245
Do	P. B. M. No. 5		286.305
Do	P. B. M. No. 6		249.851
Do	P. B. M. No. 3		273.989
Do	P. B. M. No. 2		275.714
Do	P. B. M. No. 1		287.306
West of New Fane Station, N. Y	T. B. M No. 60		314.399
West of Eighteen-mile Creek, N. Y	T. B. M. No. 59		315.994
East of Wilson, N. Y	T B M No. 53		305.839
At Wilson, N. Y	P. B. M. Wilson		289.812
East of Ransomville, N. Y	T. B M. No. 47		312.569
Do	T. B. M. No. 43		320.734
At Ransomville, N. Y	P. B. M. Ransomville		327.087
Do	T. B. M No. 41		322.998
North of Model City, N. Y	T. B M. No. 37		328.900
At Model City, N. Y	P B. M Model City		363.629
Southwest of Model City, N. Y	T. B M. No. 35		414.024
Lewiston, N. Y	P. B. M. Lewiston		401.331
At Lewiston Heights, N. Y	P. B. M. Lewiston Heights, No. 2		506.404
Do	T. B. M. No. 31		530.919
Do	P. B. M. Lewiston Heights, No. 1		600.870
North of Niagara Falls, N. Y	P. B. M. University		589.352
At Niagara Falls, N. Y	P. B. M. Suspension Bridge		584.377
Do	T. B. M. No. 24		603.480
Do	P. B. M. Echota		572.922
Do	P. B. M. Niagara, No. 1		566.547
Do	P. B. M. Niagara, No. 2		571.827
West of Lasalle, N. Y	P. B. M. Schoolhouse		575.264
At Lasalle, N. Y	P. B. M. Lasalle, No. 2		580.290
Do	P. B. M. Lasalle, No. 1		571.611

TABLE No. 1—Continued.

Place.	Designation of bench mark.	Old elevation.	New elevation.
		Feet.	*Feet.*
Near Lasalle, N. Y	T. B. M. No. 16		573.231
Do	P. B. M. Wheatfield		576.541
Near North Tonawanda, N. Y	P. B. M. Crossing		572.476
At North Tonawanda, N. Y	P. B. M. North Tonawanda, No. 2		578.822
Do	P. B. M. North Tonawanda, No. 1		579.787
At Tonawanda, N. Y	P. B. M. Tonawanda, No. 2		575.146
Do	P. B. M. Tonawanda, No. 1		576.214
Do	P. B. M. State ditch		575.154
Do	T. B. M. No. 11		585.924
Near Tonawanda, N. Y	T. B. M. No. 9		604.096
At Buffalo, N. Y	T. B. M. No. 8		603.820
Do	T. B. M. No. 7		603.603
Do	P. B. M. St. John		592.025
Do	P. B. M. Guard Lock		576.650
Do	P. B. M. Black Rock		580.216
Do	P. B. M. International Bridge No. 2		582.258
Do	P. B. M. International Bridge No. 1		579.854
Do	P. B. M. Waterworks		582.804
Do	P. B. M. Fire station		581.836
Do	P. B. M. Buffalo light-house		590.101
At Gibraltar, Mich	U. S. B. M. (1877) Gibraltar	582.45	582.528
Do	B. M. No. 2, 1875	584.97	585.041
Do	P. B. M. No. 1, 1898		587.610
At Trenton, Mich	P. B. M. No. 2, 1898		601.703
Do	U. S. B. M. (1877) Trenton	603.42	603.495
Near Sibleys Station, Mich	P. B. M. No. 3		593.461
At Wyandotte, Mich	P. B. M. No. 4		585.737
Do	B. M. Wyandotte, 1877	586.27	586.383
At Ecorse, Mich	P. B. M. No. 5		584.779
Do	P. B. M. No. 6		578.674
At Delray, Mich	P. B. M. No. 7		593.318
At Detroit, Mich	P. B. M. No. 8		601.508
Do	U. S. P. B. M. No. 9		583.009
Do	U. S. B. M. Detroit (1871)	584.78	584.814
Do	P. B. M. No. 10		592.806
Do	P. B. M. No. 11		587.561
At Windmill Point, Mich	P. B. M. No. 12		584.220
At Grosse Point, Mich	P. B. M. No. 13	592.007	592.080
At Grosse Point Farms, Mich	P. B. M. No. 35	604.865	604.938
Do	P. B. M. No. 36	606.032	606.105
South of Milk River Point, Mich	P. B. M. No. 37	584.609	584.681
At Milk River Point, Mich	P. B. M. No. 38	581.018	581.090
At L'Anse Creuse Station, Mich	P. B. M. No. 39	580.958	581.029
Near Mount Clemens, Mich	P. B. M. No. 40	580.160	580.229
Do	P. B. M. No. 41	591.110	591.179
At New Baltimore, Mich	P. B. M. No. 34	590.189	590.255
Do	P. B. M. No. 33		588.612
Do	P. B. M. No. 32		600.077
West of Fair Haven, Mich	P. B. M. No. 31		583.806
At Fair Haven, Mich	P. B. M. No. 30		583.497
At Algonac, Mich	P. B. M. No. 29		584.901
Do	P. B. M. No. 28		585.149
North of Roberts Landing, Mich	P. B. M. No. 27		585.202
At Marine City, Mich	P. B. M. No. 26		586.457
Do	P. B. M. No. 25		588.159
Do	P. B. M. No. 24		589.849
At East China, Mich	P. B. M. No. 23		590.843
At St. Clair, Mich	P. B. M. No. 22		599.676
Do	P. B. M. No. 21		588.807
Do	P. B. M. No. 20		627.298
At Marysville, Mich	P. B. M. No. 19		590.013
Do	P. B. M. No. 18		587.163
At Port Huron, Mich	P. B. M. No. 17		596.726
Do	P. B. M. No. 16		595.265
Do	P. B. M. No. 15		599.420
Do	P. B. M. No. 14		600.142
Do	B. M. Fort Gratiot Light-house (1877)	589.90	590.342
At Lakeport, Mich	P. B. M. Lakeport		595.449
At Lexington, Mich	P. B. M. Lexington No. 1		623.496
Do	P. B. M. Lexington No. 2		619.632
Do	P. B. M. Lexington No. 3		622.661
Do	P. B. M. Lexington No. 4		612.842
At Detour, Mich	P. B. M. Goetz		602.367
Do	P. B. M. Detour No. 2		586.530
Do	P. B. M. Terrett		599.699
Do	P. B. M. Detour No. 1		611.877
Do	P. B. M. Detour No. 3		591.258
Do	P. B. M. Detour No. 4		594.976
Do	P. B. M. Detour No. 5		590.460
Do	P. B. M. Boathouse		582.176
West of Detour, Mich	P. B. M. Caribou		639.441
North of Schlesser, Mich	P. B. M. Schlesser		702.923

TABLE No. 1—Continued.

Place.	Designation of bench mark.	Old elevation.	New elevation.
		Feet.	*Feet.*
At Raber, Mich	P. B. M. Raber		582.444
North of Gatesville, Mich	P. B. M. Gatesville		717.495
Do	P. B. M. Hudson		680.231
Near Tripps Corner, Mich	P. B. M. Tripp		680.806
Near Fairview, Mich	P. B. M. Fairview		687.247
Southeast of Sterlingville, Mich	P. B. M. Campbell		627.811
At Keldon, Mich	P. B. M. Munuscong		601.506
At Barbeau, Mich	P. B. M. Barbeau		660.882
South of Charlotte River, Mich	P. B. M. Charlotte		602.191
Near mouth of Charlotte River, Mich	P. B. M. 3½		600.951
North of Charlotte River, Mich	P. B. M. Hinds		592.193
South of Sault Ste. Marie, Mich	P. B. M. Newcomb		584.790
At Riverside Cemetery, Mich	P. B. M. Riverside		590.119
South of Sault Ste. Marie, Mich	P. B. M. Little		586.264
At Sault Ste. Marie, Mich	P. B. M. No. 14		586.304
Do	P. B. M. Soo		619.772
Do	P. B. M. "A"	605.872	606.069
Do	P. B. M. "B"		588.629
Do	P. B. M. Meridian		607.834
Do	P. B. M. Neaseville		641.715
Near Neaseville, Mich	P. B. M. No. 1		642.092
At Brush Point, Mich	P. B. M. Solomon		608.338
Do	P. B. M. Brush		603.721
South of Brush Point, Mich	P. B. M. No. 2		641.358
Near Gladys Station, Mich	P. B. M. No. 3		670.351
At Brimley, Mich	P. B. M. No. 4		648.038
At Bay Mills, Mich	P. B. M. Bay Mills		609.577
Near Mission, Mich	P. B. M. Mission		636.686
At Iroquois Point, Mich	P. B. M. △		618.423
Do	P. B. M. Iroquois Light-house		622.033
Do	P. B. M. Old B. M		622.707
Do	P. B. M. Iroquois No. 1		615.093
Do	P. B. M. Iroquois		608.056
At Escanaba, Mich	B. M. No. 1 (1874)	593.01	593.608
Do	B. M. No. 3 (1876)	586.52	587.118
Near Maple Ridge, Mich	B. M. No. 4 (1876)	958.64	959.219
At Sands, Mich	B. M. No. 5 (1876)	1,202.13	1,202.697
At Marquette, Mich	B. M. No. 6 (1876)	627.85	628.414
Do	B. M. No. 1 (1871)	609.93	610.489
Do	B. M. No. 2 (1874)	609.43	609.989
Do	B. M. No. 3 (1874)	609.35	609.909
Do	B. M. No. 11 (1896)		620.678
At Sacketts Harbor, N. Y	B. M. 1 (1874)	252.02	251.96
Do	B. M. 2	264.68	264.62
Do	B. M. 3 (check point) (1875)	250.35	250.29
At Charlotte, N. Y	B. M. No. 1	283.23	283.168
Do	B. M. No. 2 (1874)	253.44	253.378
At Port Dalhousie, Ontario	B. M. "A"	264.03	263.97
Do	B. M. "B"	258.05	257.99
Do	B. M. "C"	258.23	258.17
At Port Colborne, Ontario	B. M. Custom-house (1875)	584.64	584.58
Do	B. M. Baptist Church (1875)	580.44	580.38
Do	B. M. Church of England (1875)	578.99	578.93
At Erie, Pa	B. M. No. 1 (1873)	575.60	575.391
Do	B. M. U. S. Engineers		577.591
At Cleveland, Ohio	B. M. No. 1	581.50	581.407
Do	B. M. No. 2	577.83	577.737
Do	B. M. No. 3	594.82	594.727
At Amherstburg, Ontario[a]	Gauge B. M		579.172
At Sand Beach, Mich	U. S. B. M		587.814
Do	U. S. B. M. "*A*"		583.560
Do	U. S. B. M. *B*		583.174
Do	U. S. B. M. *E*		583.207
Do	U. S. B. M. Jenks		610.559
Do	U. S. B. M. Bowlder in Harbor		582.677
At Port Austin, Mich	B. M. (1873)	590.53	590.97
At Mackinaw City, Mich	B. M. No. 1		590.917
Do	B. M. No. 2		593.155
Do	B. M. No. 3		586.945
Do	B. M. R		589.941
Do	B. M. No. 4		584.141
At Milwaukee, Wis	B. M. No. 1	592.67	593.025
Do	B. M. No. 2	635.70	636.055
Do	B. M. No. 3	633.61	633.965
Do	B. M. No. 4	593.95	594.305
Do	B. M. No. 5	590.19	590.545
At Chicago, Ill	P. B. M. No. 99		591.560
At Duluth, Minn	B. M. No. 1		627.168
Do	B. M. No. 23		609.616
At Gibraltar, Mich	P. B. M. Gibraltar, 1877	582.45	582.528

[a] By precise levels, 579.337.

TABLE No. 1—Continued.

Place.	Designation of bench mark.	Old elevation.	New elevation.
		Feet.	*Feet.*
In Gibraltar, Mich	P. B. M. 2 of 1875	584.97	585.041
Do	U. S. P. B. M. 1		587.610
In South Rockwood, Mich	P. B. M. A		587.335
In Newport, Mich	P. B. M. B		580.398
In Monroe, Mich	P. B. M. C		581.064
Do	P. B. M. D		590.769
Below La Salle Station, Mich	P. B. M. E		582.323
At Vienna Station, Mich	P. B. M. F		588.827
In Lucas County, Ohio (Alexis)	P. B. M. U		585.481
In Toledo, Ohio	P. B. M. Toledo City, No. 165		596.419
Do	P. B. M. Park △		601.118
Do	P. B. M. V		589.117
Do	P. B. M. Power House		582.703
Do	P. B. M. W		603.888
Do	P. B. M. post-office		602.560
Do	P. B. M. Toledo City, No. 44		596.370
Do	P. B. M. Toledo City, No. 296		590.352
In Trenton, Mich	P. B. M. No. 2		601.703
Do	P. B. M. Trenton, 1877	603.42	603.495
Near Trenton, Mich	P. B. M. Bridge		584.556
Grosse Isle, Mich	P. B. M. Grosse Isle		584.561
Stony Island, Mich	P. B. M. Monument		577.524
Near Amherstburg, Ontario	P. B. M. Stone House		604.779
In Amherstburg, Ontario	P. B. M. Amherstburg, 1903		594.955
Do	P. B. M. Amherstburg No. 1		587.901
Do	Gauge B. M		579.337
In Monroe, Mich	P. B. M. "D"		590.769
Do	New P. B. M., M. C. R. R. Bridge		584.224
At Monroe Piers, Mich	P. B. M. Monroe Piers		578.654
Do	P. B. M. Light-house		579.886
Do	2-foot mark of gauge		574.682
In Algonac, Mich	P. B. M. 28		585.149
Herson Island, Mich	P. B. M. Herson Island		581.416
St. Clair Flats Canal	P. B. M. Upper Light		581.576
Do	P. B. M. Lower Light		581.212

COMPLETE LIST OF PERMANENT AND TEMPORARY BENCH MARKS ESTABLISHED OR CONNECTED WITH BY PRECISE LEVELS OF THE UNITED STATES LAKE SURVEY.

[Elevations are based on the United States Coast and Geodetic Survey adjustment of 1903.]

DESCRIPTIONS OF BENCH MARKS FROM RENSSELAER (GREENBUSH), N. Y., TO OSWEGO, N. Y., CONNECTED WITH OR ESTABLISHED BY PRECISE LEVELS OF UNITED STATES LAKE SURVEY, 1902.

P. B. M. Greenbush is a cross cut near the northwest corner, on the side facing the river, of the stone foundation of an old steam gristmill, near the river, at the foot of and on the south side of Second avenue, Rensselaer, N. Y. Established by the U. S. Coast and Geodetic Survey in 1857, and is known as the "Greenbush bench mark." Elevation, 4.2255 meters, 13.863 feet.

P. B. M. No. 1 is at Rensselaer, N. Y. It is the center of a ⅝-inch brass bolt, leaded horizontally in the side facing the river of the stone foundation of Irwin steam mill and elevator, near the river, at the foot of and on the south side of Second avenue. B. M. is 6.7 feet downstream from old Greenbush bench mark,

5 feet above ground, 4.3 feet upstream from upper jamb of door facing river, and 8.7 feet downstream from upper face of building. It is marked

U. S. B. M.
○
A.

U. S. Lake Survey B. M., 1902. Elevation, 4.2421 meters, 13.918 feet.

P. B. M. No. 2 is at Rensselaer, N. Y. It is the center of a $\frac{3}{8}$-inch brass bolt, leaded horizontally in the west-wing wall of south abutment of railroad bridge over Second avenue. It is 23.2 feet south of north face of south abutment, 4.5 feet above ground, and 23.2 feet north of south end of wing wall. It is marked

U. S. B. M.
○
B

U. S. Lake Survey B. M. 1902. Elevation, 7.9743 meters, 26.162 feet.

P. B. M. No. 3 is at Rensselaer, N. Y. It is a cross cut on top of stone at southwest corner of foundation of water tank at the south end of viaduct on which Broadway street crosses the N. Y. C. and H. R. R. R. tracks. U. S. Deep Waterway Survey B. M. 1898. Elevation, 6.5023 meters, 21.333 feet.

P. B. M. No. 4 is at East Albany, N. Y., on top of east shoulder of northeast end of southeast pier of upper railroad bridge across Hudson River, marked B. M. U. S. Lake Survey B. M. No. 1, 1875. Elevation, 8.0079 meters, 26.273 feet.

P. B. M. No. 5 is at Albany, N. Y., top of stone at center of cross cut into top of masonry at southwest corner of east wall of west lock. (Lock No. 1.) U. S. Lake Survey B. M. No. 2, 1875. Marked B. M. U. S. Elevation, 5.1279 meters, 16.824 feet.

P. B. M. No. 6 is at Albany, N. Y., on coping of Lock No. 2, between ends of anchor of southwest gate of west lock, marked ⊗. New York State Survey B. M. No. 5, 1901. Elevation, 7.9873 meters, 26.205 feet.

P. B. M. No. 7 is north of Albany, N. Y. Square cut in first step of towpath abutment, east end of south wing wall of D. and H. R. R. bridge over Erie Canal. New York State Survey B. M. No. 6, 1901. Marked □. Elevation, 9.1566 meters, 30.041 feet.

P. B. M. No. 8 is at Watervliet, N. Y., on coping of retaining wall at south end of towpath parapet of culvert about $1\frac{1}{4}$ miles north of D. and H. R. R. bridge over canal, marked ⊗. New York State Survey B. M. No. 7, 1901. Elevation, 7.8406 meters, 25.724 feet.

P. B. M. No. 9 is north of Watervliet, N. Y., cross cut in top of northwest end of east footiron on southeast end of southwest wall of southwest lock of Lock No. 4, Erie Canal. U. S. Lake Survey B. M. No. 6, 1875. Elevation, 14.9359 meters, 49.002 feet.

P. B. M. No. 10 is at Cohoes, N. Y., top of screwbolt fastening down iron collar of south gate of west lock of Lock No. 6, Erie, Canal. U. S. Lake Survey B. M. No. 7a, 1875. Elevation, 21.2518 meters, 69.724 feet.

P. B. M. No. 11 is at Cohoes, N. Y., top of point of coping southwest corner of east wall of west lock, Lock No. 15, Erie Canal. U. S. Lake Survey B. M. No. 8a, 1875, marked ↓. Elevation, 48.7101 meters, 159.810 feet.

P. B. M. No. 12 is at Cohoes, N. Y., on coping of Lock No. 18 between ends of anchor of southwest gate of west lock, marked ⊗. New York State Survey B. M. No. 30, 1901. Elevation, 57.9357 meters, 190.077 feet.

P. B. M. No. 13 is 2.9 miles north of Cohoes, N. Y., on top of coping at end of the south wing wall of towpath abutment of bridge No. 33, marked ⊗ B. M. New York State Survey B. M. No. 35, 1901. Elevation, 58.6105 meters, 192.291 feet.

P. B. M. No. 14 is at Crescent, N. Y., on top of parapet wall at southwest corner of southeast wing of Lower Mohawk aqueduct. Marked ⊗. New York State Survey B. M. No. 36, 1901. Elevation, 59.3196 meters, 194.618 feet.

P. B. M. No. 15 is 5 miles east of Vischers Ferry, N. Y., on projection of stone in sixth course below coping in center of face of towpath abutment of bridge No. 37. New York State Survey B. M. No. 39, 1901. Marked ⊗ B. M. Elevation, 58.8366 meters, 193.033 feet.

P. B. M. No. 16 is 3.3 miles east of Vischers Ferry, N. Y., on projection of stone in sixth course below coping in face of towpath abutment near west angle of bridge No. 39, marked ⊗ B. M. New York State Survey B. M. No. 42, 1901. Elevation, 58.6133 meters, 192.300 feet.

P. B. M. No. 17 is 2.2 miles east of Vischers Ferry, N. Y., on projection of stone

in sixth course below coping near center of face of towpath abutment of bridge No. 43, marked ⊗ B. M. New York State Survey B. M. No. 45, 1901. Elevation, 58.1407 meters, 190.750 feet.

P. B. M. No. 18 is 1 mile east of Vischers Ferry, N. Y., top of projection of stone in fifth course of masonry below coping of bridge No. 46, at east angle of south abutment (bridge is second canal bridge below Lock No. 19) marked ⊗ B. M. U. S. Lake Survey B. M. No. 12, 1875. Elevation, 58.1773 meters, 190.870 feet.

P. B. M. No. 19 is at Vischers Ferry, N. Y., a square cut on third course of masonry of east wing wall of towpath abutment of bridge No. 48, marked □. New York State Survey B. M. No. 49, 1901. Elevation, 61.9582 meters, 203.275 feet.

P. B. M. No. 20 is at Fondas Basin, N. Y., on top of coping at east end of east wing wall of towpath abutment of bridge No. 49, marked ⊗. U. S. Lake Survey B. M., 1902. Elevation, 64.6981 meters, 212.264 feet.

P. B. M. No. 21 is at Rexford, N. Y., a square cut on the northeast corner of coping of Lock No. 21, about 10 feet from end of anchor of southeast gate of south lock, marked □. New York State Survey B. M. No. 52, 1901. Elevation, 67.5196 meters, 221.521 feet.

P. B. M. No. 22 is at Rexford, N. Y., a square cut on coping of Lock No. 22, between ends of anchor of northeast gate of north lock, marked □. New York State Survey B. M. No. 53, 1901. Elevation, 70.5403 meters, 231.431 feet.

P. B. M. No. 23 is 1.8 miles west of Rexford, N. Y,, on projection of stone in lower course in face of towpath abutment of bridge No. 52, near west angle, marked ⊗ B. M. New York State Survey B. M. No. 59, 1901. Elevation, 70.5078 meters, 231.324 feet.

P. B. M. No. 24 is 1.8 miles east of Schenectady, N. Y., on second step at west end of towpath abutment of D. and H. R. R. bridge, marked □ B. M. New York State Survey B. M. No. 61, 1901. Elevation, 71.5976 meters, 234.900 feet.

P. B. M. No. 25 is at Schenectady, N. Y., is a square cut on southwest corner of coping at west end of towpath abutment of swing bridge at Schenectady Locomotive Works, marked □. New York State Survey B. M. No. 64, 1901. Elevation, 71.6674 meters, 235.129 feet.

P. B. M. No. 26 is at Schenectady, N. Y., is a square cut on first step of west wing wall of towpath abutment of Green Street Bridge over canal, marked □. New York State Survey B. M. No. 66, 1901. Elevation, 70.9986 meters, 232.935 feet.

P. B. M. No. 27 is at Schenectady, N. Y., a square cut on the southeast corner of foundation stone of the northeast column of Church street lift bridge. It is 0.9 feet from south edge of stone and 0.6 feet from the east edge, marked □. Established by the U. S. Lake Survey, 1902. Elevation, 70.9991 meters, 232.936 feet.

P. B. M. No. 28 is 1.8 miles west of Schenectady, N. Y., is a square cut on northwest corner on top of north stone in third course of stones of the east abutment of bridge No. 63, marked □. U. S. Deep Waterway B. M., 1898. Elevation, 71.6413 meters, 235.043 feet.

P. B. M. No. 29 is 2.6 miles west of Schenectady, N. Y., on top of coping of Lock No. 23, between ends of anchor of northeast gate of north lock, marked ⊗ B. M. New York State Survey B. M. No. 72, 1901. Elevation, 73.0289 meters, 239.596 feet.

P. B. M. No. 30 is 3.3 miles west of Schenectady, N. Y., is a square cut on east corner of notheast end of shelf at lower end of Lock No. 24, marked □ B. M. U. S. Deep Waterway B. M., 1898. Elevation, 73.9591 meters, 242.647 feet.

P. B. M. No. 31 is 5.6 miles west of Schenectady, N. Y., a mark cut on lower step of east wing wall of north abutment of bridge No. 67. U. S. Lake Survey B. M., 1902. Marked □. Elevation, 77.3064 meters, 253.629 feet.

P. B. M. No. 32 is east of Lock No. 25, east of Pattersonville, N. Y., is top of projection of stone in third course of stones in southeast wing wall of east abutment of bridge next below Lock No. 25, marked ⊗ B. M. U. S. Lake Survey B. M. No. 19, 1875. Elevation, 76.4894 meters, 250.949 feet.

P. B. M. No. 33 is 1.8 miles east of Pattersonville, N. Y., on corner of coping at end of west wing wall of towpath abutment of bridge No. 71, marked ⊗ B. M. New York State Survey B. M. No. 83, 1901. Elevation, 78.7224 meters, 258.275 feet.

P. B. M. No. 34 is at Pattersonville, N. Y., mark on bottom step east wing wall of north abutment of bridge No. 74. U. S. Lake Survey B. M., 1902. Marked □. Elevation, 78.9806 meters, 259.122 feet.

P. B. M. No. 35 is 2.7 miles west of Pattersonville, N. Y., mark on step of east wing wall of north abutment of bridge No. 75, marked □, 7½ inches from west edge of stone and 6 inches from south edge. U. S. Lake Survey B. M., 1902. Elevation, 79.0230 meters, 259.261 feet.

P. B. M. No. 36 is 3.5 miles east of Amsterdam, N. Y., on projection of first stone under coping of east wing wall of towpath abutment of bridge No. 76. New York State Survey B. M. No. 88. Marked ⊗ B. M. Elevation, 78.7884 meters, 258.492 feet.

P. B. M. No. 37 is 2.8 miles east of Amsterdam, N. Y., is top of east corner of coping of south wall of north lock of Lock No. 26, marked ⊗ B. M. U. S. Lake Survey B. M. No. 21, 1875. Elevation, 80.3644 meters, 263.662 feet.

P. B. M. No. 38 is 2.8 miles east of Amsterdam, N. Y., on coping of Lock No. 26, between ends of anchor of northeast gate of north lock, marked ⊗ B. M. New York State Survey B. M. No. 90, 1901. Elevation, 80.3868 meters, 263.736 feet.

P. B. M. No. 39 is 2.5 miles east of Amsterdam, N. Y., a square cut on coping of Lock No. 27, between ends of anchor of northeast gate of north lock, marked □. New York State Survey B. M. No. 91, 1901. Elevation, 82.8081 meters, 271.680 feet.

P. B. M. No. 40 is at Amsterdam, N. Y., on top of lower step at west end of towpath abutment of bridge No. 78, marked ⊗ B. M. New York State Survey B. M. No. 93, 1901. Elevation, 85.1686 meters, 279.424 feet.

P. B. M. No. 41 is at Amsterdam, N. Y., is a square cut on bottom step of west wing wall of towpath abutment of Market Street Bridge. Mark is near center of south edge of step, marked □. U. S. Lake Survey B. M., 1902. Elevation, 84.2903 meters, 276.542 feet.

P. B. M. No. 42 is at Amsterdam, N. Y., on top of coping at center pier of Chuctanunda Creek culvert, towpath side, marked ⊗ B. M. New York State Survey B. M. No. 94, 1901. Elevation, 80.3604 meters, 263.649 feet.

P. B. M. No. 43 is 2.8 miles west of Amsterdam, N. Y., is a cross cut in the top of an iron bolt in the coping of the east wall between the two locks of Lock No. 28. U. S. Lake Survey B. M. No. 24a, 1875. Elevation, 85.3220 meters, 279.927 feet.

P. B. M. No. 44 is 1 mile east of Fort Hunter, N. Y., is a square cut on coping of west wing wall of towpath abutment of bridge No. 80, first bridge east of Lock No. 29, marked □. U. S. Deep Waterway B. M., 1898. Elevation, 86.0924 meters, 282.455 feet.

P. B. M. No. 45 is at Fort Hunter, N. Y., is a square cut in first stone east of junction of old wall and extension of north wall of south lock of Lock No. 30, marked □. New York State Survey B. M. No. 100a, 1901. Elevation, 90.7997 meters, 297.899 feet.

P. B. M. No. 46 is 2 miles east of Fultonville, N. Y., on projection of stone in fourth course of stones below coping in face of abutment, near west angle, of bridge No. 88, marked ⊗ B. M. New York State Survey B. M. No. 109, 1901. Elevation, 91.5308 meters, 300.297 feet.

P. B. M. No. 47 is 1.4 miles east of Fultonville, N. Y., is a point cut on the face of the most westerly stone, about 3 feet from the corner, of the first course in the west wing wall of the north abutment of bridge No. 90. This bridge is the third east of Main Street Bridge and is about 7,000 feet east of bridge. U. S. Deep Waterway B. M., 1898. Elevation, 90.9751 meters, 298.474 feet.

P. B. M. No. 48 is at Fultonville, N. Y., on second step of east wing wall of berme abutment of Main Street Bridge, bridge No. 93, marked ⊗ B. M. New York State Survey B. M. No. 114, 1901. Elevation, 92.0643 meters, 302.048 feet.

P. B. M. No. 49 is 1.6 miles west of Fultonville, N. Y., on projection of stone in fourth course of stones below coping in face of abutment, near east angle, of bridge No. 96, marked ⊗ B. M. New York State Survey B. M. No. 117, 1901. Elevation, 91.4202 meters, 299.934 feet.

P. B. M. No. 50 is 3.0 miles west of Fultonville, N. Y., a projecting point on the upper west corner on the face of the second stone from the west corner of the west wing wall of the north abutment of bridge No. 97, the first bridge crossing the Erie Canal east of the aqueduct, about three miles west of Fultonville, N. Y. U. S. Deep Waterway Survey B. M., 1898. Marked □ B. M. Elevation, 91.2529 meters, 299.386 feet.

P. B. M. No. 51 is 3.2 miles west of Fultonville, N. Y., on top of coping at end of east wing wall of Tokkon Creek aqueduct, towpath side, marked ⊗ B. M. New York State Survey B. M. No. 120, 1901. Elevation, 90.5464 meters, 297.068 feet.

P. B. M. No. 52 is between Downing and Sprakers, N. Y., a square cut on the coping at the northeast corner of the northwest wing wall of the north wall of the second Erie Canal aqueduct west of Downing, N. Y., and about two miles west of the town. U. S. Deep Waterway B. M., 1898. Marked □. Elevation, 90.5993 meters, 297.241 feet.

P. B. M. No. 53 is 2¼ miles east of Sprakers, N. Y., is a point on the face of the

second stone from the east end in the first course of the east wing wall of the north abutment of the first bridge, No. 102, over the Erie Canal east of Lock No. 31. U. S. Deep Waterway B. M., 1898. Marked ⊗ B. M. Elevation, 91.1047 meters, 298.899 feet.

P. B. M. No. 54 is at Sprakers, N. Y., on coping of Lock No. 31, between ends of anchor of northeast gate of south lock, marked ⊗ B. M. New York State Survey B. M. No. 128, 1901. Elevation, 92.6059 meters, 303.825 feet.

P. B. M. No. 55 is at Sprakers, N. Y., is top of iron bolt in coping of west wing wall of towpath abutment of Ferry Street Bridge, No. 104. U. S. Lake Survey B. M. No. 29, 1875. Elevation, 93.0627 meters, 305.323 feet.

P. B. M. No. 56 is at Canajoharie, N. Y., on coping of parapet of northeast wing wall of Canajoharie Creek aqueduct, towpath side, marked B. M. ⊗. New York State Survey B. M. No. 135, 1901. Elevation, 93.9230 meters, 308.146 feet.

P. B. M. No. 57 is at Canajoharie, N. Y., is a cross cut near the southeast corner of the foundation of an old barn near the towpath, and just east of upper foot-bridge across the canal. Cross is cut in first stone of second course from top in south face of foundation. U. S. Lake Survey B. M. No. 31, 1875. Elevation, 93.4096 meters, 306.461 feet.

P. B. M. No. 58 is 2.4 miles east of Fort Plain, N. Y., is a point dressed square on the top of the east corner of the second course of masonry of the southeast wing wall of the northeast abutment of the first bridge, No. 113, east of the steel skew bridge of the West Shore R. R. at Fort Plain, N. Y. U. S. Deep Waterway B. M., 1898. Elevation, 93.6963 meters, 307.402 feet.

P. B. M. No. 59 is three-fourths of a mile east of Fort Plain, N. Y., on coping of Lock No. 32, between ends of anchor of northeast gate of north lock, marked ⊗ B. M. New York State Survey B. M. No. 141, 1901. Elevation, 95.1438 meters, 312.151 feet.

P. B. M. No. 60 is at Fort Plain, N. Y., on top of coping at end of west wing wall of towpath abutment of bridge No. 117, marked ⊗ B. M. New York State Survey No. 142, 1901. Elevation, 95.7792 meters, 314.236 feet.

P. B. M. No. 61 is 0.7 mile west of Fort Plain, N. Y., on projection of stone in second course above ground near center of face of towpath abutment of West Shore R. R. bridge No. 278, marked ⊗ B. M. New York State Survey B. M. No. 144, 1901. Elevation, 95.6249 meters, 313.729 feet.

P. B. M. No. 62 is 1.5 miles east of St. Johnsville, N. Y., a square cut on the south corner of the capstone of the southeast wing wall of the northeast abutment of the first bridge, No. 119, east of Lock No. 33, marked □. U. S. Deep Waterway B. M., 1898. Elevation, 95.4093 meters, 313.022 feet.

P. B. M. No. 63 is west of lock No. 33 on projection of stone in second course of masonry near center of east wing wall of towpath abutment of bridge No. 120, marked ⊗ B. M. U. S. Lake Survey B. M. No. 34, 1875. Elevation, 97.3491 meters, 319.386 feet.

P. B. M. No. 64 is at St. Johnsville, N. Y., is a square cut on top of second step of east wing wall of towpath abutment of bridge No. 121, marked □ B. M. New York State Survey B. M. No. 153, 1901. Elevation, 97.7064 meters, 320.558 feet.

P. B. M. No. 65 is about one-fourth mile west of Mindenville, N. Y., on coping of lock No. 34 between ends of anchor of northeast gate of north lock, marked ⊡ B. M. New York State Survey B. M. No. 155, 1901. Elevation, 99.2591 meters, 325.653 feet.

P. B. M. No. 66 is about 1 mile west of Mindenville, N. Y., top of a projecting point of stone in the second course of the west wing wall of the north abutment of the third bridge, No. 125, west of Lock No. 34, marked ⊗ B. M. U. S. Lake Survey B. M. No. 35a, 1875. Elevation, 100.0238 meters, 328.162 feet.

P. B. M. No. 67 is at Indian Castle, N. Y., on capstone of east wing wall of Aqueduct No. 12, towpath side, at Indian Castle, marked □ B. M. U. S. Deep Waterway B. M., 1898. Elevation, 102.0854 meters, 334.925 feet.

P. B. M. No. 68 is 2.6 miles west of Indian Castle, N. Y., a square cut on south-east corner of the capstone on the east end of the east wing wall of the north abutment of the bridge, No. 133, crossing the canal at a point about 600 feet north of the Herkimer Monument, marked □. U. S. Deep Waterway Survey B. M., 1898. Elevation, 102.6631 meters, 336.821 feet.

P. B. M. No. 69 is at Little Falls, N. Y., top of iron bolt between ends of anchor of northeast gate of north lock of Lock No. 36, marked ⊗. U. S. Lake Survey B. M. No. 37, 1875. Elevation, 104.6951 meters, 343.487 feet.

P. B. M. No. 70 is at Little Falls, N. Y., on coping of Lock No. 37 at ends of anchor of northeast gate of north lock, marked ⊗. New York State Survey B. M. 170, 1901. Elevation, 107.7553 meters, 353.527 feet.

P. B. M. No. 71 is at Little Falls, N. Y., on coping of Lock No. 38 between ends of anchor of northeast gate of north lock, marked □. New York State Survey B. M. 171, 1901. Elevation, 110.6913 meters, 363.160 feet.

P. B. M. No. 72 is at Little Falls, N. Y., on coping of Lock No. 39, at ends of anchor of northeast gate of north lock, marked ⊗. New York State Survey B. M. No. 172, 1901. Elevation, 113.7541 meters, 373.208 feet.

P. B. M. No. 73 is 2.5 miles west of Little Falls, N. Y., top of coping at the corner of the west wing wall of the north abutment of the first bridge, No. 138, east of Lock No. 40, marked with a chisel. U. S. Lake Survey B. M. No. 38a, 1875. Elevation, 115.2961 meters, 378.267 feet.

P. B. M. No. 74 is 3 miles west of Little Falls, N. Y., a cross cut on the top of the end bolt through the north branch of the iron collar of the northeast gate of the north lock of Lock No. 40. U. S. Deep Waterway B. M., 1898. Elevation, 116.1537 meters, 381.081 feet.

P. B. M. No. 75 is 5.7 miles west of Little Falls, N. Y., on coping of Lock No. 41, between ends of anchor of northeast gate of north lock, marked ⊗. New York State Survey B. M. No. 183, 1901. Elevation, 118.6194 meters, 389.170 feet.

P. B. M. No. 76 is 1 mile east of Herkimer, N. Y., a square cut on the coping of west wing wall of towpath abutment of Bridge No. 143, marked □. U. S. Lake Survey B. M. No. 39a, 1875. Elevation, 119.8858 meters, 393.325 feet.

P. B. M. No. 77 is at Herkimer, N. Y., on northeast corner of lower step of east wing wall of towpath abutment of Bridge No. 144, Herkimer Road Bridge, marked ○. New York State Survey B. M. No. 186, 1901. Elevation, 120.2414 meters, 394.492 feet.

P. B. M. No. 78 is at Mohawk, N. Y., on projection of fourteenth stone from west end in second course of towpath abutment of West Shore R. R. bridge over the canal, marked ⊗. New York State Survey B. M. No. 189, 1900. Elevation, 119.8260 meters, 393.129 feet.

P. B. M. No. 79 is one-half mile west of Mohawk, N. Y., square cut on coping of Lock No. 42, between ends of anchor of northeast gate of towpath lock, marked □. New York State Survey B. M. No. 191, 1900. Elevation, 121.4363 meters, 398.412 feet.

P. B. M. No. 80 is three-fourths mile west of Mohawk, N. Y., on northeast corner of towpath parapet wall of Fulmer Creek Aqueduct, marked ⊗. New York State Survey B. M. No. 193, 1900. Elevation, 124.3579 meters, 407.998 feet.

P. B. M. No. 81 is at Ilion, N. Y., on southwest corner of west wing wall of towpath abutment of Typewriters Bridge, marked [o]. New York State Survey B. M. No. 195, 1900. Elevation, 124.7511 meters, 409.288 feet.

P. B. M. No. 82 is at Ilion, N. Y., on west corner of coping of Steel Creek aqueduct, towpath side, marked ⊗. New York State Survey B. M. No. 197, 1900. Elevation, 124.5253 meters, 408.547 feet.

P. B. M. No. 83 is 1.1 miles west of Ilion, N. Y., a square cut on coping between ends of anchor of northeast gate, towpath lock, Lock No. 44, marked □. New York State Survey B. M. No. 200, 1900. Elevation, 127.2400 meters, 417.453 feet.

P. B. M. No. 84 is at Frankfort, N. Y., on coping of towpath lock, towpath side of Lock No. 45, two feet east of east hollow quoin, marked ⊗. New York State Survey B. M. No. 204, 1900. Elevation, 130.2493 meters, 427.326 feet.

P. B. M. No. 85 is at Frankfort, N. Y., on top of projection of stone in bottom course of stones at southeast corner of north abutment of bridge next below Lock No. 45, marked ○. U. S. Lake Survey B. M. No. 41, 1875. Elevation, 127.6240 meters, 418.713 feet.

P. B. M. No. 86 is 2.6 miles west of Frankfort, N. Y., on southwest corner of lower step of west wing wall of north abutment of Bridge No. 164, marked □. U. S. Lake Survey B. M., 1902. Elevation, 131.7771 meters, 432.339 feet.

P. B. M. No. 87 is 3.2 miles east of Utica, N. Y., on southeast corner of coping stone on the extreme east end of parapet wall of Furgeson Creek Aqueduct, marked ⊗. New York State Survey B. M. No. 215, 1900. Elevation, 130.3564 meters, 427.678 feet.

P. B. M. No. 88 is 2.1 miles east of Utica, N. Y., top of copper plug in southeast corner of lower step of east wing wall of towpath abutment of Green's road bridge at Herkimer-Oneida County line. New York State Survey B. M. No. 217, 1900. Elevation, 131.4704 meters, 431.332 feet.

P. B. M. No. 89 is at Utica, N. Y., top of copper plug in southwest corner of west end of towpath abutment of Broad Street Lift Bridge. New York State Survey B. M. No. 219, 1900. Elevation, 131.5327 meters, 431.537 feet.

P. B. M. No. 90 is at Utica, N. Y., top of copper plug in southwest corner of stone forming foundation of western stairway of Broadway Street Footbridge. New York State Survey B. M. No. 221, 1900. Elevation, 130.3669 meters 427.712 feet.

P. B. M. No. 91 is at Utica, N. Y., top of copper plug in southwest corner of west end of towpath abutment of Whitesboro Street Lift Bridge. New York State Survey B. M. No. 222, 1900. Elevation, 129.1705 meters, 423.787 feet.

P. B. M. No. 92 is at Utica, N. Y., copper plug between ends of anchor of north east gate of towpath lock of Lock No. 46. New York State Survey B. M. No. 223, 1900. Elevation, 131.1893 meters, 430.410 feet.

P. B. M. No. 93, is 1.9 miles west of Utica, N. Y., top of copper plug in lower step of east wing wall of towpath abutment of Whitesboro Road Bridge at west boundary of city of Utica. New York State Survey B. M. No. 225, 1900. Elevation, 132.8047 meters, 435.710 feet.

P. B. M. No. 94 is at Whitesboro, N. Y., top of copper plug in southeast corner of bottom step of east wing wall of towpath abutment of Clinton Street Bridge. New York State Survey B. M. No. 228, 1900. Elevation, 132.1885 meters, 433.688 feet.

P. B. M. No. 95 is at Whitesboro, N. Y., top of copper plug in bottom step of east wing wall of towpath abutment of Westmoreland Street Bridge. New York State Survey B. M. No. 229, 1900. Elevation, 132.5782 meters, 434.967 feet.

P. B. M. No. 96 is 1.8 miles east of Oriskany, N. Y., top of copper plug in southwest corner of bottom step of east wing wall of towpath abutment of Bradley's road bridge. New York State Survey B. M. No. 230, 1900. Elevation, 133.0617 meters, 436.553 feet.

P. B. M. No. 97 is at Oriskany, N. Y., top of copper plug in southwest corner of stone at west end of towpath coping of Oriskany Aqueduct. New York State Survey B. M. No. 232, 1900. Elevation, 132.2713 meters, 433.960 feet.

P. B. M. No. 98 is 1 mile west of Oriskany, N. Y., top of copper plug in southwest corner of bottom step of west wing of towpath abutment of Brainard's farm bridge. New York State Survey B. M. No. 233, 1900. Elevation, 132.8299 meters, 435.793 feet.

P. B. M. No. 99 is 4.2 miles west of Oriskany, N. Y., top of copper plug in northwest corner of east stone of parpet of Waste Wier No. 2, just below Bridge No. 31. U. S. Lake Survey B. M., 1902. Elevation, 132.0110 meters, 433.106 feet.

P. B. M. No, 100 is at Stanwix, N. Y., top of copper plug in southeast corner of bottom step of east wing wall of towpath abutment of Stanwix Road Bridge. New York State Survey B. M. No. 237, 1900. Elevation, 133.3888 meters, 437.626 feet.

P. B. M. No. 101 is at Rome, N. Y., top of copper bolt in northeast corner of east wall of Black River feeder to Erie Canal, 100 feet west of center of Depeyster Street Bridge over canal. Whitesboro street crosses feeder by an arch marked S. W. Morton, contractor, 1851. U. S. Lake Survey B. M., 1902. Elevation, 132.1325 meters, 433.505 feet.

P. B. M. No. 102 is at Rome, N. Y., square cut in the southwest corner of lower step at west end of north abutment of George Street Bridge, marked B. M. □. U. S. Lake Survey B. M., 1902. Elevation, 132.9204 meters, 436.090 feet.

P. B. M. No. 103 is 1.1 miles west of Rome, N. Y., top of copper plug in bottom step of east wing wall of towpath abutment of Barnes's farm bridge. New York State Survey B. M. No. 239, 1900. Elevation, 132.6692 meters, 435.266 feet.

P. B. M. No. 104 is 2.7 miles west of Rome, N. Y., top of copper plug in southeast corner of end stone on west end of parapet of Fort Bull waste wier. U. S. Lake Survey B. M., 1902. Elevation, 132.0165 meters, 433.124 feet.

P. B. M. No. 105 is 4.8 miles west of Rome, N. Y., top of copper plug in lower step of west wing wall of towpath abutment of Armstrong's farm bridge. New York State Survey B. M. No. 241, 1900. Elevation, 132.7074 meters, 435.391 feet.

P. B. M. No. 106 is at New London, N. Y., top of copper plug in bottom step of east wing wall of towpath abutment of New London road bridge. New York State Survey B. M. No. 243, 1900. Elevation, 132.6912 meters, 435.338 feet.

P. B. M. No. 107 is at Stacys Basin, N. Y., top of a copper plug in lower step of east wing wall of towpath abutment of bridge No. 49. New York State Survey B. M. No. 245, 1901. Elevation, 132.7852 meters, 435.646 feet.

P. B. M. No. 108 is at Stacys Basin, N. Y., top of projection of stone in second course of stones of east wing wall of north abutment of bridge No. 49. U. S. Lake Survey B. M. No. 49, 1875. Elevation, 132.2432 meters, 433.868 feet.

P. B. M. No. 109 is 1 mile east of Higginsville, N. Y., top of projection of stone in bottom course of east wing wall of north abutment of Bridge No. 50. U. S. Lake Survey B. M. No. 51, 1875. Elevation, 131.3843 meters, 431.050 feet.

P. B. M. No. 110 is at Higginsville, N. Y., top of copper plug in second step of east wing wall of towpath abutment of east road bridge at Higginsville, Bridge No. 51. New York State Survey B. M. No. 247, 1901. Elevation, 132.0622 meters, 433.274 feet.

P. B. M. No. 111 is 2.4 miles west of Higginsville, N. Y., nail in the root of a 2-foot maple tree on fence line on south side of road, the largest tree in the vicinity, about 2,000 feet west of intersection of roads about 2½ miles west of Higginsville, along old side cut to Oneida Lake. U. S. Lake Survey B. M., 1902. Elevation, 114.3846 meters, 375.277 feet.

P. B. M. No. 112 is at Sylvan Junction, N. Y., square cut on top of east end of south abutment of N. Y. O. and W. R. R. bridge over Fish Creek at Sylvan Junction, N. Y., marked

U. S. B. M.
□

U. S. Lake Survey B. M., 1902. Elevation, 114.9148 meters, 377.016 feet.

P. B. M. No. 113 is at North Bay, N. Y., nail in root on north side of a 14-inch maple tree in the northeast corner of Sautell's field, about 400 feet west of depot and about 60 feet south of N. Y. O. and W. R. R. track. U. S. Lake Survey B. M., 1902. Elevation, 118.0230 meters, 387.214 feet.

P. B. M. No. 114 is 1.7 miles west of North Bay, N. Y., top of a ⅝-inch brass bolt leaded vertically in a 1.2-foot by 1.2-foot by 0.5-foot triangular stone buried 2.7 feet below ground in the north side of the highway in front of the ruins of John Kinney's house. It is 70 feet northeast of northeast corner of barn on south side of road, 161 feet east of large willow tree; 104 feet east of fence opposite barn; 6.4 feet south of stone wall on north side of road; 12 feet south of most westerly tree in row of maple trees on north side of road; and 1.4 feet west of center of surface stone, which projects 4 inches above ground and whose dimensions are 2.6 feet by 1.2 feet by 0.6 foot. Surface stone is in line with western wall of foundation of burned house on the John Kinney farm. Surface stone marked U. S. B. M. H. U. S. Lake Survey B. M., 1902. Elevation, 128.6620 meters 422.119 feet.

P. B. M. No. 115 is at Cleveland, N. Y., top of a ⅝-inch brass bolt leaded vertically in a 1.4-foot by 1.4-foot by 0.5-foot stone buried 2½ feet below surface of ground at center of intersection of Bridge and North streets. It is 120 feet east of center of bridge over Black Creek; 37.5 feet north of fence on south side of Bridge street; 172 feet south of southwest corner of St. James Episcopal Church; 71.2 feet south of hydrant on west side of North street; and 1.6 feet west of surface stone marked U. S. B. M., which projects 2 inches above ground and whose dimensions are 2.2 feet by 1.0 feet by 0.5 foot. U. S. Lake Survey B. M., 1902. Elevation, 120.3240 meters, 394.763 feet.

P. B. M. No. 116 is at Cleveland, N. Y., top of a copper nail in root of maple tree 2½ feet in diameter, 100 feet west of second highway crossing the N. Y. O. and W. R. R. west of railroad siding and 540 feet west of mile post marked N. Y. 285. U. S. Deep Waterway B. M., 1898. Elevation, 128.9328 meters, 423.007 feet.

P. B. M. No. 117 is at Bernhardts Bay, N. Y., top of a ⅝-inch brass bolt leaded vertically in a 1.2-foot by 0.8-foot by 0.5-foot stone buried 2½ feet under the surface of the ground on the north side of the road opposite J. Richardson's blacksmith shop. It is 26 feet west of east line of foundation of C. Winn's burned store; 15 feet north of center of road and opposite center of blacksmith shop; 148 feet east of center of bridge over small brook west of blacksmith shop; 25 feet southeast of southwest corner of ruins of C. Winn's store; 79 feet southwest of Sarah Jane Mickle's house on north side of road; 59 feet north of northeast corner of blacksmith shop; and 1.5 feet east of center of surface stone which projects 2 inches above ground, whose dimensions are 1.7 feet by 0.9 foot by 0.5 foot, marked U. S. B. M. U. S. Lake Survey B. M., 1902. Elevation, 117.8435 meters, 386.625 feet.

P. B. M. No. 118 is at Constantia, N. Y., top of a ⅝-inch brass bolt leaded vertically, 4.8 feet north of north rail of track, in corner of stone in coping at north end of west abutment of culvert No. 395, just east of N. Y. O. and W. depot, over second creek east of depot, marked

U. S. B. M.
R

U. S. Lake Survey B. M., 1902. Elevation, 119.9925 meters, 393.675 feet.

P. B. M. No. 119 is about one-half mile west of Constantia, N. Y., top of a *copper nail* in root on south side of a chestnut tree two feet in diameter, 15 feet north of the north right-of-way line of the N. Y. O. and W. R. R., and 305 feet east of highway crossing railroad about one-half mile west of depot. U. S. Deep Waterway B. M., 1898. Elevation, 125.1865 meters, 410.716 feet.

P. B. M. No. 120 is at West Monroe, N. Y., top of a 30 d. spike in root on south side of third elm tree, the third from cross road to depot, in a row of four large elm trees on the south side of the main road opposite Cross and Wrightman's store. U. S. Lake Survey B. M., 1902. Elevation, 120.4269 meters, 395.101 feet.

P. B. M. No. 121 is at Central Square, N. Y., a square cut on the northwest corner of door step of door of Low's store, facing band stand, marked

U. S. B. M.
□

U. S. Lake Survey B. M., 1902. Elevation, 138.3719 meters, 453.975 feet.

P. B. M. No. 122 is about one-fourth mile west of Caughdenoy Depot, N. Y., a square cut on coping on north side of east abutment of N. Y. O. and W. R. R. bridge No. 420, first railroad bridge west of Caughdenoy Depot. It is 0.8 foot east of west face of abutment; 1 foot west of step; and 4.8 feet north of north rail of track, marked

U. S. B. M.
□

U. S. Lake Survey B. M., 1902. Elevation, 116.0473 meters, 380.732 feet.

P. B. M. No. 123 is at Pennellville, N. Y., top of a $\frac{3}{8}$-inch brass bolt leaded vertically in a 1.5-foot by 1.5-foot by 0.6-foot stone buried $3\frac{1}{2}$ feet under surface of ground in west side of school yard, 57.8 feet from northwest corner of schoolhouse; 67.4 feet northwest from the southwest corner of the schoolhouse; 111.8 feet north of the northwest corner of Methodist Protestant Church; in line with the north face of schoolhouse; and is 1.7 feet west of a 0.6-foot by 0.9-foot by 2.5-feet surface stone which is 34.6 feet east of center of road on west side of schoolhouse and 119.3 feet south of center of road on north side of schoolhouse. It projects 4 inches above ground and is marked

U. S. B. M.
W

U. S. Lake Survey B. M., 1902. Elevation, 125.7206 meters, 412.468 feet.

P. B. M. No. 124 is 2.8 miles southeast of Fulton, N. Y., center of a $\frac{1}{4}$-inch brass bolt leaded horizontally in a brick in the west face near the northwest corner of W. M. Whalin's brick house on south side of Pennellville-Fulton road. Bolt is 2.45 feet from northwest corner of house and 3.9 feet above ground, marked U. S. B. M., U. S. Lake Survey B. M., 1902. Elevation, 121.8719 meters, 399.841 feet.

P. B. M. No. 125 is at Fulton, N. Y., top of a copper plug between anchor irons of east leaf of north gate of Lock No. 8, Oswego Canal. U. S. Lake Survey B. M., 1902. Elevation, 106.0543 meters, 347.947 feet.

P B. M. No. 126 is at Fulton, N. Y., top of a copper plug between anchor irons of east leaf of north gate of Lock No. 10, Oswego Canal. U. S. Lake Survey B. M., 1902. Elevation, 100.2870 meters, 329.025 feet.

P. B. M. No. 127 is at Fulton, N. Y., top of a copper plug in coping of south wing wall of towpath abutment of first bridge below Lock No. 10. U. S. Lake Survey B. M., 1902 Elevation, 98.5014 meters, 323.167 feet.

P. B. M. No. 128 is at Fulton, N. Y., top of a copper plug, flush with the masonry, in first step of south wing wall of east abutment of highway bridge over Oswego Canal on N. First street. New York State Survey B. M. No. 19, 1901. Elevation, 98.2898 meters, 322.472 feet.

P. B. M. No. 129 is 0.6 mile north of Fulton, N. Y., top of a copper plug between anchor irons of east leaf of middle gate of Lock No. 11. U. S. Lake Survey B. M., 1902. Elevation, 97.5918 meters, 320.182 feet.

P. B. M. No. 130 is 1.6 miles north of Fulton, N. Y., top of a copper plug between anchor irons of east leaf of middle gate of Lock No. 12. U. S. Lake Survey B. M., 1902. Elevation, 95.1001 meters, 312.008 feet.

P. B. M. No. 131 is at Minetto, N. Y., top of a copper bolt, flush with masonry, between anchor irons on northeast lower hollow quoin stone of Lock No. 13. New York State Survey B. M. No. 21, 1901. Elevation, 91.8154 meters, 301.231 feet.

P. B. M. No. 132 is 0.6 mile north of Minetto, N. Y., top of copper plug flush with masonry, between anchor irons of east leaf of north gate of Lock No. 14. U. S. Lake Survey B. M., 1902. Elevation, 88.8892 meters, 291.631 feet.

P. B. M. No. 133 is 2 miles south of Oswego, N. Y., top of a copper plug, flush with masonry, between anchor irons on northeast lower hollow quoin stone of Lock No. 15. New York State Survey B. M. No. 22. Elevation, 87.3778 meters, 286.672 feet.

P. B. M. No. 134 is 0.6 mile south of Oswego, N. Y., top of a copper bolt between anchor irons of east leaf of north gate of guard, Lock No. 5. U. S. Lake Survey B. M., 1902. Elevation, 82.7754 meters, 271.572 feet.

P. B. M. No. 135 is 0.3 mile south of Oswego, N. Y., top of a copper plug between anchor irons of east leaf of north gate of Lock No. 17. U. S. Lake Survey B. M., 1902. Elevation, 83.7339 meters, 274.717 feet.

P. B. M. No. 136 is at Oswego, N. Y., top of a $\frac{5}{8}$-inch brass bolt leaded vertically in coping between anchor irons of east leaf of middle gate of Lock No. 18. U. S. Lake Survey B. M., 1902. Elevation, 78.9027 meters, 258.867 feet.

P. B. M. No. 137 is at Oswego, N. Y., center of a $\frac{5}{8}$-inch brass bolt leaded horizontally in water table under chimney at northwest corner of North Western Elevator at the foot of Schuyler street. Bolt is on the north face, 8.9 feet east of northwest corner, marked

U.S.B.M.
o
3

U. S. Lake Survey B. M., 1902. Elevation, 77.7164 meters, 254.975 feet.

P. B. M. No. 138 is at Oswego, N. Y., a circle two centimeters in diameter cut on the highest point of the large bowlder marking the site of Fort Oswego at the foot of West First street. Circle is 7.3 feet from southeast post of iron fence around the bowlder and 7.17 feet from the southwest post. U. S. Lake Survey B. M., 1902. Elevation, 80.0310 meters, 262.568 feet.

P. B. M. No. 139 is at Oswego, N. Y., is the top of a $\frac{5}{8}$-inch brass bolt leaded vertically in top of masonry of old Government pier at the foot of West Third street. It is 68.9 feet north of old U. S. L. S. B. M. "A," 1875; 72.4 feet north of dock running east; 0.6 foot from east face of dock; 86 feet south of rear face of dock running east toward light-house; 35.2 feet northeast of bottom step of elevated portion of dock; marked

U.S.B.M.
⊡
No.1.

U. S. Lake Survey B. M., 1902. Elevation, 76.7284 meters, 251.733 feet.

P. B. M. "A" is at Oswego, N. Y., top of an iron bolt in top of masonry of old Government pier at foot of West Third street, 0.5 foot from east face of masonry, 3.5 feet north of north face of wooden dock leading to Government boathouse: bolt is sunk one-half inch below top of masonry, marked B. M. U. S. Lake Survey B. M., 1875. Elevation, 76.7788 meters, 251.898 feet.

P. B. M. "B" is at Oswego, N. Y., top of stone post in prolongation south of west face of stone pier at the foot of West Third street; 8 feet south of masonry of pier; top of post is flush with the ground and is at one of the southwest corners of the Government reservation. U. S. Lake Survey B. M. "B," 1875. Elevation, 76.9355 meters, 252,413 feet.

P. B. M. "C" is at Oswego, N. Y., a cross cut on shop of dry dock of marine railroad at foot of West Second street. Cross is in third course of stones from ground on west side of shop and 3 feet north of southwest corner. U. S. Lake Survey B. M. "C," 1875. Elevation, 79.8506 meters, 261.977 feet.

Descriptions and Elevations of Permanent and Temporary Bench Marks Along the St. Lawrence River from the Saint Regis Reservation to Cape Vincent, N. Y.

P. B. M. "A" is at Saint Regis, Canada. It is the center punch mark in $\frac{1}{4}$-inch brass bolt cemented into the west side of the northwest corner of tower of Saint Regis Catholic Church, 10 inches from said corner and about 19 inches above the surface of the ground. The letters "U. S. A." are cut into the stone. U. S. Deep Waterway B. M., 1898. Elevation, 51.7697 meters, 169.848 feet.

P. B. M. "B" is at Saint Regis, Canada. It is the center punch mark in a $\frac{1}{4}$-inch brass bolt cemented into the south face and 6 inches from the southwest corner of the priest's house opposite the Catholic Church. The bolt is 6 inches above surface of the ground and the letters "U. S. B." are cut into the foundation stone. U. S. Deep Waterway B. M., 1898. Elevation, 50.8662 meters, 166.884 feet.

T. B. M. 4 is at Saint Regis, Canada. It is the highest point of a cast-iron boundary line post on Canadian-United States boundary line. The post is 550 meters southeast from Saint Regis Catholic Church on the northwest side of the Hogansburg-Saint Regis road. U. S. Deep Waterway B. M., 1898. Elevation, 51.5172 meters, 169.020 feet.

T. B. M. 3 is 1 mile south of Saint Regis, Canada. It is the top of a small knob on a bowlder 2 feet by 3 feet situated on the east side of the Hogansburg-Saint Regis road at the crest of the hill: 3½ feet west from fence line and near the main turn in the road 1,700 meters southwest from Saint Regis dock. U. S. Deep Waterway B. M., 1898. Elevation, 55.5838 meters, 182.361 feet.

P. B. M. "P" is at Hogansburg, N. Y., the center punch mark in ¼-inch brass bolt cemented into the northeast face of the east buttress of the main tower of Saint Patrick's Catholic Church. The bolt is 21 inches below the water table and 18 inches above the ground. The letters "U. S. P." are cut into the foundation masonry. U. S. Deep Waterway B. M., 1898. Elevation, 54.3337 meters, 178.260 feet.

P. B. M. "C" is at Hogansburg, N. Y., the center punch mark in ¼-inch brass bolt cemented into the southeast face 1 foot from the east corner of the Catholic convent at Hogansburg. The bolt is in the limestone water table about 2 feet above the surface of the ground and the letters "U. S. C." are cut into the stone. U. S. Deep Waterway B. M., 1898. Elevation, 54.8489 meters, 179.950 feet.

P. B. M. 1 is near the mouth of the Raquette River; it is the top of a round-headed brass bolt set in a concrete base about 350 feet northwest of the northwest bank of the Raquette River and 20.5 feet southeast of the center of a large pine tree 9 feet in circumference and blazed 12 inches by 17 inches. The tree is the largest pine tree near the Raquette River and the blaze is marked the same as the concrete base, "U. S. P. B. M. 1." The bench mark is covered by about 1 foot of earth. When visited in 1902 tree had been cut down. U. S. Deep Waterway B. M., 1898. Elevation, 52.3896 meters, 171.882 feet.

T. B. M. 11 is 1 mile west of mouth of Raquette River, the top of small knob on a bowlder situated 50 feet southeast of a schoolhouse, 10 feet east of a fence and 15 feet north of fence corner at southeast corner of schoolhouse yard. U. S. Deep Waterway B. M., 1898. Elevation, 55.2846 meters, 181.380 feet.

T. B. M. 15 is 1¼ miles east of mouth of Grass River, the top of highest knob on a bowlder 6 feet by 4 feet by 4 feet, situated 40 meters north of 18-inch elm, S. 60° W. from center span of New York and Ontario Railroad bridge, 2,000 meters E, 10° S. from mouth of Grass River and 350 meters southeast from end of Grass River road. U. S. Deep Waterway B. M., 1898. Elevation, 69.2652 meters, 227.248 feet.

P. B. M. 2 is near the mouth of the Grass River, the top of a round-headed brass bolt set into a concrete base on the north side of the Grass River road, just east of the mouth of the Grass River. The bench is 3 feet south of the north fence line of the road and on the west fence line of house lot of William Tucker. The bench was set 1.2 feet underground and marked on the concrete base, "U. S. P. B. M. 2." U. S. Deep Waterway B. M., 1898. Elevation, 63.3929 meters, 207.982 feet.

T. B. M. 17 is north of the mouth of the Grass River, the top of small knob on a flat bowlder situated at east edge of a clearing about 25 meters south of gully, 175 meters west of St. Lawrence River, and 300 meters north from mouth of Grass River. U. S. Deep Waterway B. M., 1898. Elevation, 53.9148 meters, 176.885 feet.

T. B. M. 19 is 1 mile northwest from the mouth of the Grass River, the top of a spike in root of 24-inch elm tree situated on south side of river road, 250 meters east of turn in road, said turn being 1,900 meters west of Polly's Gut. U. S. Deep Waterway B. M., 1898. Elevation, 56.6372 meters, 185.817 feet.

P. B. M. 3 is 2¼ miles west of Polly's Gut, the top of a round-headed brass bolt set into a concrete base 3 feet south of fence on the north side of river road, and in the center of the north and south road branching off the river road opposite the farm of John Wood. The bench is 25 feet east of a honey-locust hedge on the west line of said farm, and is 1.3 feet under the surface of the ground. The concrete base is marked "U. S. P. B. M. 3." U. S. Deep Waterway B. M., 1898. Elevation, 62.2945 meters, 204.378 feet.

T. B. M. 22 is 3 miles west of the mouth of Grass River, top of knob on a bowlder situated at Robinsons Bay, on west side of river road, near fence line of road, 600 meters northeast of Robinson's residence and 600 meters E. 10° N. from mouth of Robinsons Creek. U. S. Deep Waterway B. M., 1898. Elevation, 58.8413 meters, 193.048 feet.

P. B. M. 4 is opposite the head of Barnharts Island, the top of a round-headed ¼-inch brass bolt set into a concrete base 1.4 feet underground and situated on the south side of the river road, on line of a stone fence running north and south opposite the barnyard of Frank Polly's farm. The bench is 5.5 feet from the south fence of the road and 420 feet east of Pollys Creek, and is marked on the

concrete base, "U. S. P. B. M. 4." U. S. Deep Waterway B. M., 1898. Elevation, 67.4761 meters, 221.378 feet.

T. B. M. 27 is opposite the foot of Long Sault Island, top of knob on a bowlder situated 15 meters north of stone fence on north side of river road, 100 meters east of house on south side of road, 125 meters east of house on north side of road, and 475 meters west of Pollys Creek. U. S. Deep Waterway B. M., 1898. Elevation, 83.7848 meters, 274.885 feet.

T. B. M. 30 is 2½ miles below head of Massena Canal, top of knob on southeast corner stone of foundation of Carton's brick residence, 2,400 meters southwest from Pollys Creek on river road. U. S. Deep Waterway B. M., 1898. Elevation, 71.1620 meters, 233.470 feet.

P. B. M. 5 is 1½ miles below head of Massena Canal, the top of a round-headed ¼-inch brass bolt set into a concrete base 1.2 feet below the surface of the ground and situated on the north side of the river road at the corner of the fence in the turn in the road at the house of Norman Hopson. The bench is 2.8 feet from the fence corner and is marked, "U. S. P. B. M. 5." U. S. Deep Waterway B. M., 1898. Elevation, 75.3947 meters, 247.357 feet.

T. B. M. 33 is 800 meters east of Massena Canal, top of a knob on a bowlder situated at junction of Massena and river roads, on north side of river road 2 meters south of fence. U. S. Deep Waterway B. M., 1898. Elevation, 79.6287 meters, 261.248 feet.

T. B. M. 35 is 200 meters west of Massena Canal, the top of spike in root of a 30-inch elm tree situated on the south fence line of the river road. U. S. Deep Waterway B. M., 1898. Elevation, 67.8755 meters, 222.688 feet.

P. B. M. 6 is 1¼ miles above Massena Canal, the top of a round-headed ¼-inch brass bolt set into a concrete base 1.3 feet underground, 3 feet north of the south fence line of the river road, and 58.5 feet east of the east fence of Isaac Richard's residence, at Richards Landing. The bench is marked on the concrete base "U. S. P. B. M. 6." U. S. Deep Waterway B. M., 1898. Elevation, 70.8298 meters, 232.381 feet.

T. B. M. 38 is 2¼ miles above the head of Massena Canal, the top of a spike in the root of a 15-inch elm situated on the north side of river road opposite brick residence of Robert McGee, midway between Richards Landing and Louisville Landing. U. S. Deep Waterway B. M., 1898. Elevation, 77.9215 meters, 255.648 feet.

T. B. M. 39 is 1 mile below Louisville Landing, N. Y., the top of a spike in the root of an 18-inch maple situated in front of the residence of Mrs. Sutton, on the north side of the river road, 15 meters west of gully and 1,700 meters east of Louisville Landing. U. S. Deep Waterway B. M., 1898. Elevation, 70.4935 meters, 231.278 feet.

T. B. M. 40 is 700 meters east of Louisville Landing, N. Y., the top of spike in the root of a 30-inch elm situated 6 meters south of south fence line of the river road, and 25 meters west of the residence of Norman McCloud. U. S. Deep Waterway B. M., 1898. Elevation, 73.6432 meters, 241.612 feet.

P. B. M. Louisville Landing is at Louisville Landing, N. Y., the center punch mark of a ¼-inch brass bolt cemented into the west face of the hotel of R. B. Mathews, at Louisville Landing, 2.6 feet from the northwest corner of the building, in a foundation stone, 0.9 feet above the ground, marked "U. S." U. S. Deep Waterway B. M., 1898. Elevation, 70.1072 meters, 230.010 feet.

T. B. M. 41 is 800 meters above Louisville Landing, N. Y., the top of a spike in the root of an 18-inch oak situated on the north side of the river road, 70 meters west of Weegar residence. U. S. Deep Waterway B. M., 1898. Elevation, 65.0575 meters, 213.443 feet.

T. B. M. 44 is 2¼ miles above Louisville Landing, N. Y., the top of a spike in the root of a 4½-foot elm situated in front of James Whalen's residence, on the river road. U. S. Deep Waterway B. M., 1898. Elevation, 73.4992 meters, 241.139 feet.

P. B. M. 7 is 2¼ miles above Louisville Landing, N. Y., the top of a round-headed ¼-inch brass bolt set into a concrete base 1.4 feet underground and situated on the north side of the river road, 22.7 feet west and on west fence line of Charles Whalen's house. The bench is 3 feet east of said Whalen fence and on the fence line of the river road and is marked "U. S. P. B. M. 7." U. S. Deep Waterway B. M., 1898. Elevation, 68.3396 meters, 224.211 feet.

T. B. M. 45 is 2¾ miles above Louisville Landing, N. Y., the top of a spike in a 3½-foot elm situated 25 meters southwest of the brick residence of Nathan Bush, on property line between Bush and Bingham estates on north side of the river road and northeast of Wilson's hill. U. S. Deep Waterway B. M., 1898. Elevation, 75.4774 meters, 247.629 feet.

T. B. M. 46 is 3¼ miles above Louisville Landing, N. Y., the top of a spike in the root of a 4½-foot elm tree situated on the south side of the river road at the foot of southwest slope of Wilson's hill, west of Wilson's barns, 105 meters east of the residence of John Stone. U. S. Deep Waterway B. M., 1898. Elevation, 74.5513 meters, 244.591 feet.

T. B. M. 47 is 3¾ miles above Louisville Landing, N. Y., the top of a knob on a bowlder situated on the south side of the river road, 150 meters west of large angle in road, 400 meters east of road to Wilson's dock. U. S. Deep Waterway B. M., 1898. Elevation, 71.3114 meters, 233.961 feet.

P. B. M. 8 is 4½ miles above Louisville Landing, N. Y., on top of a round-headed ¼-inch copper bolt set into the top of a large granite bowlder in the orchard on the north side of the river road on the crest of Bradford hill, 6.8 feet north of the north fence line on the river road opposite the home of William Bradford on Bradford's hill. The bowlder is marked "U. S. P. B. M. 8." U. S. Deep Waterway B. M., 1898. Elevation, 79.0699 meters, 259.415 feet.

T. B. M. 50 is 2½ miles below mouth of Coles Creek, the top of a spike in the root of a 4½-foot elm situated on the north side of the river road, 35 meters west of the residence of Henry Bradford. U. S. Deep Waterway B. M., 1898. Elevation, 73.1439 meters, 239.973 feet.

T. B. M. 51 is 1½ miles below the mouth of Coles Creek, the top of a spike in the root of a 20-inch elm tree situated on the north side of the river road, 100 meters west of the residence of Mrs. Lawrence. U. S. Deep Waterway B. M., 1898. Elevation, 73.3048 meters, 240.500 feet.

T. B. M. 53 is 1,500 meters below the mouth of Coles Creek; it is the top of a spike in the root of a 24-inch elm situated on the north fence line of the river road at Power's farm, 200 meters west of the residence of Guy D. Powers. U. S. Deep Waterway B. M., 1898. Elevation, 72.7738 meters, 238.758 feet.

P. B. M. 9 is about 600 meters northeast of the bridge across Coles Creek near its mouth; it is the top of a round-headed ¼-inch brass bolt set into a concrete base 1.2 feet below the ground, on the north side of the river road abreast of Egg Island (or Ruthefords or Carrs Island) in Coles Creek. The bench is nearly on said north road line and 5.8 feet south of the south corner of a large wooden barn of William Hosmer, and on the concrete base is marked "U. S. P. B. M. 9." U. S. Deep Waterway B. M., 1898. Elevation, 72.7944 meters, 238.826 feet.

T. B. M. 56 is ¾ mile above the mouth of Coles Creek; it is the top of a spike in the root of a 30-inch hard maple situated in front of the residence of Fred Jerome on the north side of the river road at angle of the road, 1,200 meters above Coles Creek and about 4 miles below Waddington, N. Y. U. S. Deep Waterway B. M., 1898. Elevation, 72.8989 meters, 239.169 feet.

P. B. M. 10 is 2½ miles below Waddington, N. Y.; it is the top of a round-headed ¼-inch brass bolt set into a concrete base covered by 1.2 feet of earth and situated on the north side of the river road, 4.2 feet south of the north fence line and on the property line between Dartis and Scott lots, abreast of Murphys Island. The concrete base is marked "U. S. P. B. M. 10." U. S. Deep Waterway B. M., 1898. Elevation, 72.0133 meters, 236.264 feet.

T. B. M. 60 is 2 miles below Waddington, N. Y.; it is the top of a spike in the root of a 24-inch elm tree situated on the south side of river road, 125 meters west of cross road to the south, 800 meters east of Mud Creek. U. S. Deep Waterway B. M., 1898. Elevation, 74.1979 meters, 243.431 feet.

T. B. M. 62 is 1¼ miles below Waddington, N. Y.; it is the top of a spike in the root of a 36-inch white-pine tree situated on the north side of the river road, 130 meters east of James Brennen's brick residence at bend in the road. U. S. Deep Waterway B. M., 1898. Elevation, 74.6114 meters, 244.788 feet.

T. B. M. 64 is at Waddington, N. Y.; is the top of a spike in the root of a 24-inch maple tree 23 meters north of center of river road, on east side of a street running parallel with the main business street of Waddington and two blocks east of said main street. U. S. Deep Waterway B. M., 1898. Elevation, 76.7934 meters, 251.947 feet.

P. B. M. 11 is at Waddington, N. Y.; is the center punch mark on a ¼-inch brass bolt cemented into the upper foundation stone, 3 inches from the south corner and 24 inches above the ground, on the southwest face of St. Paul's Episcopal Church; the letters "U. S. 11." are cut into the stone. U. S. Deep Waterway B. M., 1898. Elevation, 84.8567 meters, 278.401 feet.

P. B. M. "A" is at Waddington, N. Y.; is the center punch mark on a ¼-inch brass bolt cemented into the south buttress of the steeple of the Presbyterian Church, 12 feet northeast from the center of the main entrance, 1.6 feet from the outer corner of said buttress, and 1.5 feet above the ground. Bench mark is

marked "U. S. A." U. S. Deep Waterway B. M., 1898. Elevation, 83.1748 meters, 272.883 feet.

P. B. M. "B" is at Waddington, N. Y.; is the center punch mark on a ¼-inch brass bolt cemented into the foundation masonry on the northeast face, 1.9 feet from the north corner, and 0.8 foot above the ground on the town hall. Bench mark is marked "U. S. B." U. S. Deep Waterway B. M., 1898. Elevation, 84.1448 meters, 276.065 feet.

T. B. M. 67 is 1 mile above Waddington, N. Y.; it is the top of a knob on a bowlder situated on the south side of the river road, 44 meters west of cross fence to the south, 23 meters southeast from a 36-inch elm tree, and 4 meters north of the road. U. S. Deep Waterway B. M., 1898. Elevation, 82.2018 meters, 269.690 feet.

T. B. M. 69 is 1¾ miles above Waddington, N. Y., being top of a spike in the root of a 14-inch elm on the north side of the river road, 25 meters east of cross-road to Leshmans Point. U. S. Deep Waterway B. M., 1898. Elevation, 78.5973 meters, 257.864 feet.

T. B. M. 70 is 2¼ miles above Waddington, N. Y., being top of spike in root of a 30-inch pine situated on the south side of the river road, 80 meters southeast from the residence of Luther Marshall. U. S. Deep Waterway B. M., 1898. Elevation, 76.5109 meters, 251.019 feet.

T. B. M. 71 is 2⅞ miles above Waddington, N. Y., being top of highest knob on a 3-meter by 3½ meter boulder situated on the north side of the river road 20 meters southwest from the Nevin residence on the Dalzell farm owned by John Harper, 300 meters east of White House Creek at bend in road. U. S. Deep Waterway B. M., 1898. Elevation, 75.9516 meters, 249.184 feet.

P. B. M. 12 is 3½ miles above Waddington, N. Y., being the top of a round-headed ¼-inch brass bolt cemented into the top of a large granite bowlder on the south side of the river road at the turn just west of Point Three Points (better known as White House or Waddells Point); the bowlder forms the end of a stone wall near the entrance to the property of Waddell and is marked "U. S. P. B. M. 12." U. S. Deep Waterway B. M., 1898. Elevation, 77.2048 meters, 253.296 feet.

T. B. M. 74 is 1¾ miles above White House Creek, being top of knob on a bowlder situated on the south side of the river road 50 meters southeast from the brick residence of Mr. Edsell. U. S. Deep Waterway B. M., 1898. Elevation, 77.7294 meters, 255.017 feet.

T. B. M. 75 is 1 mile north from Tilden Post-Office, N. Y., being the top of a spike in root of 24-inch maple tree situated on north side of the river road at its intersection with the driveway to Clark's residence and 25 meters southeast of Clark's residence. U. S. Deep Waterway B. M., 1898. Elevation, 82.6975 meters, 271.317 feet.

P. B. M. 13 A is at Tilden Post-Office, N. Y., is the top of a round headed ¼-inch brass bolt cemented into the top of a bowlder on the north side of the river road, and on the east property line of Tilden Post-Office, just opposite Iroquois Point. The bowlder is marked "U. S. P. B. M. 13 A." U. S. Deep Waterway B. M., 1898. Elevation, 83.3396 meters, 273.423 feet.

P. B. M. 13 is at Tilden Post-Office, N. Y., is the center punch mark in a ¼-inch brass bolt cemented into foundation stone of Tilden Post-Office situated on the north side of the river road on the town line between Lisbon and Waddington, N. Y. The mark is on the southeast face of the building, 7.2 feet from the south corner and 0.8 feet above the ground. The letters "U. S." are cut into the stone. U. S. Deep Waterway B. M., 1898. Elevation, 82.2820 meters, 269.954 feet.

T. B. M. 77 is 800 meters above Tilden Post-Office, N. Y., being the top of a spike in the root of a 24-inch elm tree situated on the south side of the river road at cross fence to the south, N. 10° E. 138 meters from the residence of James Thompson, northeast 160 meters from residence of Thomas Thompson. U. S. Deep Waterway B. M., 1898. Elevation, 81.3646 meters, 266.944 feet.

T. B. M. 78 is 1¼ miles above Tilden Post-Office, N. Y., being top of a spike in the root of a 30-inch elm tree situated on the south side of the river road, 1,600 meters below Boice Post-Office, 200 meters west of schoolhouse, 240 meters west of cross-road to the south, and 100 meters west from the residence of Miles Putney. U. S. Deep Waterway B. M., 1898. Elevation, 82.5716 meters, 270.904 feet.

T. B. M. 79 is 1¾ miles above Tilden Post-Office, N. Y., being top of a spike in the root of a 3-foot elm tree situated on the north side of the river road, 900 meters below Boice Post-Office, opposite the brick residence of Mr. Gray. U. S. Deep Waterway B. M., 1898. Elevation, 83.3828 meters, 273.565 feet.

T. B. M. 80 is 250 meters below Boice Post-Office, being top of a spike in the root of a 20-inch cherry tree situated on the south fence line of the river road, 20 meters

south of the butter factory, which is at the south edge of a gully. U. S. Deep Waterway B. M., 1898. Elevation, 80.9259 meters, 265.504 feet.

P. B. M. 14 is 1 mile above Boice Post-Office, N. Y., being the top of a round headed ¼-inch brass bolt set into a concrete base, covered by 1 foot of earth, on the north side of the river road at the bend in the road, on the east property line of Silas Samon's property. The bench is 7 feet west from a large sugar maple tree blazed and marked "U. S." The concrete base is marked "U. S. P. B. M. 14," U. S. Deep Waterway B. M., 1898. Elevation, 83.3706 meters, 273.525 feet.

T. B. M. 83 is opposite Lotus Island, N. Y., being the top of a spike in the root of a 30-inch elm situated on the north side of the river road, 150 meters west of the 9th mile post below Ogdensburg, and 50 meters east of the residence of George Sparrowhawk. U. S. Deep Waterway B. M., 1898. Elevation, 84.4561 meters, 277.086 feet.

P. B. M. 15 is 7 miles below Ogdensburg, N. Y., being center punch mark in a ¼-inch brass bolt cemented into the corner stone on the west corner of the Episcopal stone church at Lisbon Post-Office. The church is on the south side of the river road. The bench is on the north face of the church, 10 inches from the west corner, 28 inches above the ground, and is marked "U. S. 15." U. S. Deep Waterway B. M., 1898. Elevation, 84.9550 meters, 278.723 feet.

T. B. M. 86 is 300 meters west of Lisbon Post-Office, N. Y., being the top of a spike in the root of a 24-inch elm tree on the north side of the river road. U. S. Deep Waterway B. M., 1898. Elevation, 80.0012 meters, 262.470 feet.

T. B. M. 87 is 1,400 meters above Lisbon Post-Office, N. Y., being top of a knob on a bowlder 4 feet by 3 feet by 3 feet situated on the north side of the river road, 50 meters east from the residence of Aldan Dawson and 40 meters below the 6th mile post northeast from Ogdensburg. U. S. Deep Waterway B. M., 1898. Elevation, 94.7242 meters, 310.774 feet.

T. B. M. 88 is 1¾ miles above Lisbon Post-Office, N. Y., being the top of a spike in the root of a 36-inch elm tree situated on the north side of the river road 2,500 meters below Tibbetts Creek, in front of the residence of Rupert on the Rider farm. U. S. Deep Waterway B. M., 1898. Elevation, 91.8634 meters, 301.388 feet.

T. B. M. 89 is 15 meters below Tibbetts Creek, being the top of a knob on a 6-foot by 3-foot by 3-foot bowlder situated on the north side of the river road, 20 meters west of the residence of M. McDonald. U. S. Deep Waterway B. M., 1898. Elevation, 93.7625 meters, 307.618 feet.

T. B. M. 90 is 700 meters below Tibbetts Creek, being top of a spike in the root of a 36-inch elm tree situated on the north side of the river road in front of the residence of F. P. Briggs. U. S. Deep Waterway B. M., 1898. Elevation, 87.7477 meters, 287.885 feet.

P. B. M. 16 is 3 miles below Ogdensburg, N. Y., being the center punch mark in a ¼-inch brass bolt cemented into red sandstone coping on the north side of the infirmary building in the New York State Hospital grounds, below Ogdensburg, N. Y. The mark is 12.7 feet from the west corner of said building and 50.5 feet from center of doorway on the north side, and is 4 feet above the ground. The letters "U. S." are cut into the coping above the mark. U. S. Deep Waterway B. M., 1898. Elevation, 86.0240 meters, 282.230 feet.

T. B. M. 95 is at Ogdensburg, N. Y., the top of a knob on large stone of highway bridge over the O. and L. C. R. R. tracks, situated in the northeast outskirts of Ogdensburg; said stone is at north end of iron railing on west side of north abutment. U. S. Deep Waterway B. M., 1898. Elevation, 87.6796 meters, 287.661 feet.

T. B. M. 96 is at Ogdensburg, N. Y., being the top of a spike in the root of a 36-inch elm tree situated in Ogdensburg, on the south side of Green street, in front of house at the southwest corner of Green and Judson streets. U. S. Deep Waterway B. M., 1898. Elevation, 83.5935 meters, 274.255 feet.

Gage B. M. "O" is at the lower end of Ogdensburg, N. Y., square cut on the northwest corner of the sandstone water table of the small brick office near the automatic-gage house; it is about 300 feet above the "Lower Elevator" and 350 feet below George Hall's coal trestle. U. S. Lake Survey B. M., 1900. Elevation, 75.3246 meters, 247.126 feet.

P. B. M. "A" is at Ogdensburg, N. Y., being the center punch mark of a ¼-inch brass bolt cemented into a 12-inch by 18-inch red sandstone on the southwest corner of the Armory Building, Ford street, Ogdensburg, 34 inches above the surface of the ground. The letters "U. S. A." are cut into the masonry. U. S. Deep Waterway B. M., 1898. Elevation, 84.7033 meters, 277.897 feet.

P. B. M. "B" is at Ogdensburg, N. Y., being the center punch mark of a ¼-inch brass bolt cemented into a 12-inch by 18-inch foundation stone on the southeast

face of the town hall and opera house, corner of Ford and Caroline streets. The mark is on the west half of said face and 6.25 feet from the southwest corner of the building, and 2.25 feet from the surface of the ground. The letters "U. S. B." are cut into the masonry. U. S. Deep Waterway B. M., 1898. Elevation, 85.5713 meters, 280.745 feet.

P. B. M. "C" is at Ogdensburg, N. Y., being center punch mark in a ¼-inch brass bolt cemented into a corner coping stone on the northeast corner of the U. S. custom-house, State street, Ogdensburg. The mark is 7½ inches west of said corner of building, on the north face, 4 feet and ½ inch above the sidewalk. The letters "U. S. C." are cut into the coping stone. U. S. Deep Waterway B. M., 1898. Elevation, 88.3547 meters, 289.877 feet.

T. B. M. 99 is at Ogdensburg, N. Y., being top of a knob on curbstone on the west side of Lake Street, 54½ inches north of high stone on the abutment of highway bridge over the Oswegatchie River. U. S. Deep Waterway B. M., 1898. Elevation, 79.5877 meters, 261.114 feet.

T. B. M. 100 is at Ogdensburg, N. Y., on top of knob on a bowlder situated in Ogdensburg in yard of N. Y. C. and H. R. R. R., 40 meters north from center of turntable in front of N. Y. C. and H. R. R. R. roundhouse, 40 meters west of north end of the N. Y. C. and H. R. R. R. station house and 30 meters northwest from railroad water tank. U. S. Deep Waterway B. M., 1898. Elevation, 75.8698 meters, 248.916 feet.

P. B. M. "D" is at Ogdensburg, N. Y., being the center punch mark in a ¼-inch brass bolt cemented into the coping stone on the north face of the United States light-house on the west pier at the mouth of the Oswegatchie River. The mark is 48½ inches southwest of the north corner of the house and 32½ inches above the surface of the ground. The letters "U. S. D." are cut into the coping stone. U. S. Deep Waterway B. M., 1898. Elevation, 76.5117 meters, 251.022 feet.

T. B. M. 102 is at Ogdensburg, N. Y., on top of a knob on a bowlder situated in the southwest outskirts of Ogdensburg, in the ditch on the south side of the N. Y. C. and H. R. R. R., 4 meters south of track, 90 meters east of stone cross fence, 275 meters east of lumber-yard mill dock and quarry. U. S. Deep Waterway B. M., 1898. Elevation, 79.2216 meters, 259.913 feet.

P. B. M. 17 is 3 miles above Ogdensburg, N. Y., being the top of a round-headed ¼-inch brass bolt set into a concrete base 12 inches below the surface of the ground, 31.7 feet south of the center of the track of the N. Y. C. and H. R. R. R. near Nevins Point, 3 miles above Seymour House, Ogdensburg, N. Y. The bench is 25.5 feet north of a 30-inch elm tree blazed and marked "U. S.," also about 200 feet south of a stone ice-house and about 250 feet northeast of a stone barn; the concrete base is marked "U. S. P. B. M. 17" and the same letters are cut into a large bowlder in the corner of the fence about 10 feet northwest of the bench. U. S. Deep Waterway B. M., 1898. Elevation, 79.0644 meters, 259.397 feet.

T. B. M. 105 is 4¼ miles above Ogdensburg, N. Y., on top of a knob on a bowlder situated 1¼ miles above Nevins Point, in a ditch 3 meters north of the center line of the N. Y. C. and H. R. R. R. track, 100 meters northeast of butter factory. U. S. Deep Waterway B. M., 1898. Elevation, 79.6733 meters, 261.395 feet.

T. B. M. 106 is 2 miles above Nevins Point, on top of knob on a 4-foot by 2-foot stone on the southwest wing wall of stone culvert on the N. Y. C. and H. R. R. R., about 100 meters east of a long point projecting out into the St. Lawrence River. U. S. Deep Waterway B. M., 1898. Elevation, 77.7151 meters, 254.971 feet.

P. B. M. 18 is 6 miles above Ogdensburg, N. Y., on the top of a square-headed ¼-inch brass bolt cemented into bed rock 6 inches underground, about 900 feet northwest from house of Le Rock, 45.6 feet northwest of center of the track of the N. Y. C. and H. R. R. R., 292.5 feet northeast of section post 23–24 of this railroad, 6 miles above the Seymour House, Ogdensburg, N. Y. The bench is 124 feet west of a wagon road leading from Le Rock's house to the St. Lawrence River, and about 200 feet southwest from a small stone boathouse on the river bank. The letters "U. S. P. B. M. 18" are cut into the bed rock. U. S. Deep Waterway B. M., 1898. Elevation, 75.9099 meters, 249.048 feet.

T. B. M. 108 is 4¼ miles below Morristown, N. Y., on top of knob on bed rock, 3⅝ miles above Nevins Point, 3½ meters north of the center line of the N. Y. C. and H. R. R. R. track, 13.5 meters from blaze on a telegraph pole. The line to telegraph pole is at right angles to line of railroad; T. B. M. is 125 meters east of cross fence. U. S. Deep Waterway B. M., 1898. Elevation, 78.4172 meters, 257.274 feet.

T. B. M. 109 is 3½ miles below Morristown, N. Y., on top of knob on bed rock, 4⅜ miles above Nevins Point, 3 meters south from the center line of the N. Y. C. and H. R. R. R. track, 16 meters west of culvert, 7 meters west from blaze on telegraph pole, and 90 meters east of 14-inch elm tree. U. S. Deep Waterway B. M., 1898. Elevation, 79.0276 meters, 259.278 feet.

P. B. M. 19 is 2 miles below Morristown, N. Y., the top of a ¼-inch round-headed brass bolt cemented into bed rock 25.8 feet northwest from the center line of track of the N. Y. C. and H. R. R. R., 52 feet southeast of a ledge of rock on the St. Lawrence River bank on Dows Point, N. 20° W., 1,000 feet from the residence of George Beattie, 9 miles above Ogdensburg. The bench is 331 feet southwest from the southwest corner of summer cottage Rock Ledge, E. 5° S. from Brockville Asylum, Canada, and 60 feet northwest from a blazed telegraph pole. The letters U. S. P. B. M. are cut into the bed rock, which is covered by 6 inches of earth. U. S. Deep Waterway B. M., 1898. Elevation, 76.0008 meters, 249.346 feet.

T. B. M. 112 is 1,200 meters northeast from Morristown, N. Y., on top of a knob on a boulder, situated 7 meters north of the center line of the N. Y. C. and H. R. R. R., 10 meters west of railroad culvert at west end of Terrace Park clearing. U. S. Deep Waterway B. M., 1898. Elevation, 78.2547 meters, 256.740 feet.

P. B. M. "A" is at Morristown, N. Y., being the center punch mark in a ¼-inch brass bolt cemented into the coping stone on the northwest corner of lumber office of the Gillies Bros. Co., Ltd., in the northwest end of Morristown, N. Y. The building is of limestone and is owned by Frank Chapman. The bench mark is on the north face of said building, 6 inches from the northwest corner and about 18 inches above the ground. The bench is marked "U. S. A." U. S. Deep Waterway B. M., 1898. Elevation, 83.1155 meters, 272.688 feet.

P. B. M. "B" is at Morristown, N. Y., being the center punch mark in a ¼-inch brass bolt cemented into a corner stone of the foundation masonry of a stone warehouse, 68 feet west and across the road from P. B. M. "A." The bench is on the east face of said building, 8 inches from the southeast corner, 79.5 feet from the north side of the United States custom-house, and 117 feet east of the center of main track of the N. Y. C. and H. R. R. R. The letters "U. S. B." are cut into the stone. U. S. Deep Waterway B. M., 1898. Elevation, 82.6888 meters, 271.288 feet.

P. M. B. "C" is at Morristown, N. Y., being the center punch mark in a ¼-inch brass bolt cemented into masonry on the east face of the south wing of the residence of Henry Chapman, on the west side of the bay at Morristown. The bench mark is 39 inches north of the southeast corner of said wing, and 17 inches above the surface of the ground. The letters "U. S. C." are cut into the masonry. U. S. Deep Waterway B. M., 1898. Elevation, 78.6380 meters, 257.998 feet.

T. B. M. 114 is ⅞ of a mile above Morristown, N. Y., on top of knob on bed rock on the south side of the river road, 4 meters north of stone fence, 5 meters west of cross fence to the south, and 55 meters northeast from stone residence of Hiram Holten. U. S. Deep Waterway B. M., 1898. Elevation, 81.7906 meters, 268.351 feet.

T. B. M. 116 is 1⅛ miles above Morristown, N. Y., on top of knob on a boulder situated on the north side of the river road at the west end of stone wall at the foot of the hill west of Mr. Holmes' residence, 100 meters from water gage. U. S. Deep Waterway B. M., 1898. Elevation, 75.2492 meters, 246.880 feet.

P. B. M. 20 is 1.6 miles above Morristown, N. Y., being the top of a round-headed ¼-inch brass bolt cemented into a slab of limestone rock embedded in sand and gravel near the shore of the St. Lawrence River, on the east side of a small bay, and on range with the upper end of Old Mans Island and Umbrella Island. The bench is at the foot of a ledge of rock at Rowleys or Housers Point, 6 feet from the face of a ledge and about 180 feet north of the river road, marked "U. S. P. B. M. 20." U. S. Deep Waterway B. M., 1898. Elevation, 75.2022 meters, 246.736 feet.

T. B. M. 118 is 2⅝ miles above Morristown, N. Y., on top of knob on a boulder situated on the south side of the river road 65 meters west of bend in the road and 33 meters east of cross fence to the south. U. S. Deep Waterway B. M., 1898. Elevation, 86.8016 meters, 284.782 feet.

T. B. M. 120 is 4 miles below Oak Point, N. Y., on top of knob on bed rock situated on the northeast side of the river road where it runs northwest and southeast, about 150 meters southeast from a right-angled turn in said road to the northeast, at top of a hill, 1 meter southwest of fence, 1,000 meters northwest of cheese factory. U. S. Deep Waterway B. M., 1898. Elevation, 98.2618 meters, 322.381 feet.

T. B. M. 121 is 3⅞ miles below Oak Point, N. Y., on top of a knob on bed rock situated in a field about 800 meters northwest from cheese factory, 15 meters southeast of a lone 8-inch elm tree, blighted, 50 meters southeast from fence intersection, and 20 meters south of fence. U. S. Deep Waterway B. M., 1898. Elevation, 99.9913 meters, 327.399 feet.

P. B. M. 21 is 2½ miles below Oak Point, N. Y., being the top of a round-headed ¼-inch brass bolt cemented into the top of a boulder (5 feet by 3 feet) projecting 2

feet above the surface of the ground and situated on the north side of the river road in a turn of this road and opposite the center of a cross road running southeast from the river road and about ¾ of a mile east of town line between the towns of Morristown and Hammond, 1.000 meters northeast from the cross road known as the Blackstone road. The letters "U. S. P. B. M. 21" are cut into the boulder. U. S. Deep Waterway B. M., 1898. Elevation, 104.5567 meters, 343.033 feet.

T. B. M. 123 is 2 miles below Oak Point, N. Y., on top of a knob on a boulder 3 meters southeast of southeast fence line of river road on northeast side of Blackstone road—a cross road. U. S. Deep Waterway B. M., 1898. Elevation, 97.7251 meters, 320.620 feet.

P. B. M. 22 is at Oak Point, N. Y., being the top of a round-headed ¼-inch brass bolt cemented into sandstone bed rock 6 inches below the surface of the ground and 3 feet from the south fence line of the river road and 71 feet from the southeast fence corner of the intersection of the river road and the road going north into Old Point village. The bench is N. 32° E. from intersection of center lines of said river road and Oak Point Road, on the crest of the hill ¼ mile south of Oak Point village. The bench is marked "U. S. P. B. M. 22." U. S. Deep Waterway B. M., 1898. Elevation, 103.3980 meters, 339.232 feet.

P. B. M. Oak Point is ¼ mile south of Oak Point, N. Y., top of a round-headed ¼-inch brass bolt cemented into sandstone bed rock, 18 inches below surface of the ground on the west side of the road to Oak Point village and 22 meters northwest from the intersection of river road and said Oak Point road. The bench is 39 meters west of P. B. M. 22 and 1.7 meters south from a large boulder marked "U. S. P. B. M. O. P." with an arrow pointing to the B. M. The same letters are also cut into the bed rock. U. S. Deep Waterway B. M., 1898. Elevation, 103.1528 meters, 338.427 feet.

T. B. M. 127 is 1¼ miles southeast from Oak Point, N. Y., on top of a knob on bed rock on east side of road, 6 meters west of fence and 7 meters west of 18-inch elm tree. U. S. Deep Waterway B. M., 1898. Elevation, 107.8855 meters, 353.954 feet.

T. B. M. 128 is 1¾ miles southeast from Oak Point, N. Y., on top of a knob on a large boulder situated in pasture west of road. 1 meter west of fence and 65 meters north of stone residence of David Moore. U. S. Deep Waterway B. M., 1898. Elevation, 113.2030 meters, 371.400 feet.

T. B. M. 129 is 2 miles southeast of Oak Point, N. Y., on top of knob on a boulder situated 200 meters northwest of Tildens Corners on east fence line of road, 32 meters south of an 18-inch elm tree. U. S. Deep Waterway B. M., 1898. Elevation, 115.6216 meters, 379.336 feet.

T. B. M. 131 is 2½ miles southeast from Oak Point, N. Y., on top of a knob on a bowlder situated 75 meters south of foot of Marvins hill and 100 meters north of cheese factory cross road. U. S. Deep Waterway B. M., 1898. Elevation, 80.5508 meters, 264.272 feet.

P. B. M. 23 is 3¼ miles southeast from Oak Point, N. Y., being the top of a round-headed ¼-inch brass bolt cemented into sandstone bed rock in the valley of the Chippewa Creek, S. 70° W. 375 meters from the iron bridge over said creek. The bench is northeast from the stone residence of Alex. and Robert Moore, in Chippewa Valley, 25 meters south from a 30-inch blazed white oak, and 2 meters west from a bare surface on the rock into which the letters "U. S. P. B. M. 23" are cut, with an arrow pointing to the bench mark. The same letters are cut in the rock around the B. M. The mark is covered by about 6 inches of earth. U. S. Deep Waterway B. M., 1898. Elevation, 79.2576 meters, 260.031 feet.

T. B. M. 133 is situated 2¼ miles northeast from Chippewa Village, N. Y., on top of knob in bed rock on southeast side of road opposite residence of Mr. Moore, 20 meters northeast from a bend in the road. U. S. Deep Waterway B. M., 1898. Elevation, 79.4266 meters, 260.585 feet.

P. B. M. 23a is 2¼ miles northeast of Chippewa Village, N. Y., being a horizontal line cut in the center of a smooth square surface on the face, 1.3 inches east of the southwest corner and 22 inches above the ground, on the stone dwelling house of Alex. and Robert More, in Chippewa Creek Valley, on the river road. The letters "U. S. 23a" are cut into the masonry around the mark. U. S. Deep Waterway B. M., 1898. Elevation, 79.0627 meters, 259.392 feet.

T. B. M. 134 is 1½ miles northeast of Chippewa Village, N. Y., on top of knob on bed rock, on east side of river road, about 100 meters east of an old barn. U. S. Deep Waterway B. M., 1898. Elevation, 79.4619 meters, 260.702 feet.

P. B. M. 24 is at Chippewa Village N. Y., on top of a ¼-inch round-headed brass bolt cemented into bed rock 4.8 feet north of northwest corner of a barn on the

property of Mrs. Alex. Wilson, of Brockville, Canada, and is 130 feet west from the house on said farm. The bench is 400 meters southwest from P. B. M. C. V. and is covered by 3 inches of soil. The letters "U. S. P. B. M. 24" are cut into the bed rock. U. S. Deep Waterway B. M., 1898. Elevation, 88.4935 meters, 290.332 feet.

P. B. M. Chippewa Village is at Chippewa Village, N. Y., being the center punch mark in ½-inch brass bolt cemented into a corner stone on the north face of the northeast corner of schoolhouse of district No. 11. The schoolhouse is built of sandstone masonry and is founded on bed rock. The mark is 18 inches west from the northeast corner of said schoolhouse and 38 inches above bed rock. The letters "U. S. C. V." are cut into the masonry near the bolt. U. S. Deep Waterway B. M., 1898. Elevation, 88.6050 meters, 290.698 feet.

T. B. M. 138 is 1⅛ miles south of Chippewa Village, N. Y., on top of knob on bed rock on east side of river road, 300 meters north of an 18-inch elm tree at the foot of a steep hill. U. S. Deep Waterway B. M., 1898. Elevation, 97.6434 meters, 320.353 feet.

T. B. M. 139 is 1½ miles south of Chippewa Village, N. Y., top of knob on a bowlder on southwest side of river road, 85 meters southeast from top of steep hill and turn in the road; about 500 meters northwest from schoolhouse. U. S. Deep Waterway B. M., 1898. Elevation, 110.6233 meters, 362.937 feet.

T. B. M. 141 is 2¼ miles south of Chippewa Village, N. Y., top of spike in root of 30-inch elm tree, situated 1,100 meters southwest of schoolhouse on southeast side of Callaboga road, 60 meters east of stone residence of Mr. Browdie. U. S. Deep Waterway B. M., 1898. Elevation, 116.1692 meters, 381.133 feet.

T. B. M. 143 is 3¼ miles south from Chippewa Village, N. Y., top of knob on a bowlder on north side of Callaboga road, 70 meters northeast of cross road to southeast and 100 meters southwest from Callaboga schoolhouse. U. S. Deep Waterway B. M., 1898. Elevation, 113.9393 meters, 373.816 feet.

P. B. M. 25 is 3½ miles south of Chippewa Village, N. Y., top of a round-headed ½-inch brass bolt cemented into bed rock about three-fourths of a mile northeast from county line between Jefferson and St. Lawrence counties near the Callaboga road, on the property of Geo. Schermerhorn. The bench is at the southwest end of a stone fence, forming a road fence for the property of Wm. Catlin, and is about half way between the dwelling of said Schermerhorn and Catlin. It is 11.8 feet northwest of the fence on the northwest side of the Callaboga road and 69.1 feet west from a blazed 14-inch elm tree on the south side of the road. The letters "U. S. P. B. M. 25" are cut into the bed rock and the bench is covered by 6 inches of earth. U. S. Deep Waterway B. M., 1898. Elevation, 111.9048 meters, 367.141 feet.

T. B. M. 145 is 5¼ miles southwest of Chippewa Village, N. Y., top of a spike in root of 18-inch elm situated on county line between St. Lawrence and Jefferson counties on southeast side of road, about 300 meters east of Chas. Cole's residence. U. S. Deep Waterway B. M., 1898. Elevation, 107 6639 meters, 353.229 feet.

T. B. M. 146 is 6 miles southwest of Chippewa Village, N. Y., top of knob on bed rock situated 800 meters southwest of county line between St. Lawrence and Jefferson counties, on north side of Callaboga road, 50 meters northeast from top of hill on east side of Crooked Creek Valley, 2 meters north of a 4-inch maple. U. S. Deep Waterway B. M., 1898. Elevation, 103.8709 meters, 340.783 feet.

T. B. M. 148 is 1⅝ miles southwest of the county line between St. Lawrence and Jefferson counties, top of knob on bed rock on west side of road in Crooked Creek Valley, at southwest end of bridge over a branch of Crooked Creek, about 1,000 meters northeast of Springer's mill. U. S. Deep Waterway B. M., 1898. Elevation, 76.0649 meters, 249.555 feet.

T. B. M. 150 is 2¼ miles southwest of the county line, top of knob on bed rock situated on the west side of Crooked Creek Valley at the crest of a hill, 12 meters northeast of road and 500 meters west of Springer's sawmill at an angle in the road. U. S. Deep Waterway B. M., 1898. Elevation, 82.6903 meters, 271.292 feet.

P. B. M. 26 is 4 miles below Alexandria Bay, N. Y., top of a round-headed ½-inch brass bolt cemented into bed rock on the property of Geo. Springer, 111 feet south of the center line of the river road, 836 feet northeast from the intersection of the river road and the northwest and southeast road to Redwood, N. Y., three-fourths of a mile southwest from Springer's mill, on Crooked Creek, 238 feet southeast from a frame house on the north side of the river road and 141.7 feet south from the barn near the house. The bench is on a flat surface of the bed rock just where the surface drops off toward Cranberry Creek. The letters "U. S. P. B. M. 26" are cut into the rock. U. S. Deep Waterway B. M., 1898. Elevation, 101.7341 meters, 333.740 feet.

T. B. M. 151 is 4 miles northeast from Alexandria Bay, N. Y., top of knob on bed rock situated opposite Goose Bay on west side of road running northwest and southeast, at middle of jog in road, 20 meters south of schoolhouse. U. S. Deep Waterway B. M., 1898. Elevation, 105.5654 meters, 346.342 feet.

T. B. M. 152 is 3 miles northeast from Alexandria Bay, N. Y., top of knob on a bowlder situated 100 meters northeast of crest of hill at east side of Cranberry Creek Valley, on northwest side of road, 100 meters northeast of a farm house. U. S. Deep Waterway B. M., 1898. Elevation, 98.6861 meters, 323.872 feet.

T. B. M. 153 is 2½ miles northeast from Alexandria Bay, N. Y., top of knob on bed rock situated in Cranberry Creek Valley, on east side of road, 50 meters west of east branch of Cranberry Creek, 30 meters south of bridge over creek, and 100 meters north from Hodge's residence. U. S. Deep Waterway B. M., 1898. Elevation, 78.6714 meters, 258.108 feet.

T. B. M. 154 is 2 miles northeast from Alexandria Bay, N. Y., top of knob on a bowlder, 30 meters east of the foot of Reisters Hill, 18 meters north of road. U. S. Deep Waterway B. M., 1898. Elevation, 78.3312 meters, 256.992 feet.

T. B. M. 155 is 2 miles northeast of Alexandria Bay, N. Y., on top of knob on bed rock, on north fence line of road at top of Reisters Hill. U. S. Deep Waterway B. M., 1898. Elevation, 103.7107 meters, 340.258 feet.

T. B. M. 156 is 1¾ miles northeast from Alexandria Bay, N. Y., top of knob on bed rock, on south side of road, at an angle in the road 250 meters east of residence of Mr. Castleman. U. S. Deep Waterway B. M., 1898. Elevation, 91.5455 meters, 300.444 feet.

P. B. M. 27 is 1½ miles northeast from Alexandria Bay, N. Y., top of a round-headed ¼-inch brass bolt cemented into bed rock, on the property of C. M. Tamblin, 50.5 feet south of the south fence line of the river road. The mark is on ledge of bed rock raised above the surrounding ground and about 300 feet east from the barn of C. M. Tamblin and 193.5 feet southeast from a small frame house on the north side of the river road. The bench is covered by 6 inches of earth, and the letters "U. S. P. B. M. 27" are cut into the rock at the bench. The same letters are cut into the exposed rock adjacent to the bench, and two arrows cut into the rock point to the position of the bench. U. S. Deep Waterway B. M., 1898. Elevation, 83.3734 meters, 273.534 feet.

T. B. M. 157 is three-fourths mile east of Alexandria Bay, N. Y., top of knob on bed rock, on south fence line of road, 165 meters southwest from schoolhouse. U. S. Deep Waterway B. M., 1898. Elevation, 97.8707 meters, 321.098 feet.

T. B. M. 158 is one-fourth mile east of Alexandria Bay, N. Y., top of knob on bed rock, on north side of road, 50 meters west of angle in road. U. S. Deep Waterway B. M. 1898. Elevation, 82.2154 meters, 269.735 feet.

T. B. M. 159 is at Alexandria Bay, N. Y., top of knob on bed rock, on south side of street, which is a continuation of the River road, at south end of first street east of Church street, two blocks from Thousand Island House and 30 meters back from schoolhouse. Bench mark is covered with 2 inches of dirt. Two arrows pointing toward the bench are cut on the exposed surface of the rock. U. S. Deep Waterway B. M., 1899. Elevation, 80.9865 meters, 265.704 feet.

P. B. M. "A" is at Alexandria Bay, N. Y., being the center punch mark in a ¼-inch brass bolt cemented in the water table or coping stone on the west side, 8 meters from the southwest corner of the stone building known as "general store" of Cronwall Bros. The mark is 2.3 feet above the surface of the ground and the letters "U. S. A." are cut into the masonry. U. S. Deep Waterway B. M., 1899. Elevation, 78.9934 meters, 259.164 feet.

P. B. M. "B" is at Alexandria Bay, N. Y., being the center punch mark in the end of a ¼-inch brass bolt cemented into a stone on the front of the Reform Church. The mark is 0.64 meter above the surface of the ground and 1.79 meters northwest of the east corner of the church. The letters "U. S. B." are cut into the masonry. U. S. Deep Waterway B. M., 1899. Elevation, 86.6374 meters, 284.243 feet.

T. B. M. 160 is at Alexandria Bay, N. Y., top of knob on bed rock, on the north side of road, 70 meters southwest of the bridge at south end of the bay at Alexandria Bay. U. S. Deep Waterway B. M., 1899. Elevation, 78.1514 meters, 256.402 feet.

T. B. M. 161 is three-fourths mile above Alexandria Bay, N. Y., top of knob on bed rock on north side of road, 60 meters northeast of a crossroad to the south, 35 meters east of the residence of Carl Snyder, 33 meters northwest of the residence of Philander Lackey. The position of the mark is indicated by an arrow cut on the bed rock pointing southwest toward the mark. U. S. Deep Waterway B. M., 1899. Elevation, 80.7896 meters, 265.057 feet.

P. B. M. 28 is 3 miles above Alexandria Bay, N. Y., top of a round-headed ¼-inch

brass bolt cemented into bed rock. It is one-fourth mile east of Geo. Clyde's residence, 10 feet southeast of a fence which runs S. 66° E. from the east corner of a large barn on the southeast side of the road, 161.5 feet from the east corner of the barn, 450 feet from a crossroad leading to the river, and 225 feet southeast of the southeast fence line of Clayton-Alexandria Bay road. The letters "U. S. P. B. M. 28" are cut on the bed rock. U. S. Deep Waterway B. M., 1899. Elevation, 88.0630 meters, 288.920 feet.

T. B. M. 165 is 3¾ miles above Alexandria Bay, N. Y., on top of a knob on a bowlder situated 2½ miles below Fisher Landing, on south side of road, 30 meters east of a cut through a gravel pit. U. S. Deep Waterway B. M., 1899. Elevation, 81.7701 meters, 268.273 feet.

T B. M. 166 is 4¼ miles above Alexandria Bay, N. Y., top of knob on a bowlder situated 1½ miles below Fisher Landing, on south side of road at a crossroad leading to the river. U. S. Deep Waterway B. M., 1899. Elevation, 90.3261 meters, 296.345 feet.

T. B. M. 168 is 5¾ miles above Alexandria Bay, N. Y., top of knob on a large bowlder situated one-fourth mile below Fisher Landing, on north side of road, 90 meters west of a prominent angle in road. U. S. Deep Waterway B. M., 1899. Elevation, 80.7397 meters, 264.894 feet.

P. B. M. 29 is one-half mile southeast of Fisher Landing, N. Y., on top of a round-headed ¼-inch brass bolt, cemented into bed rock 6 inches below the surface of the ground, in front of Mrs. Tom's residence, 2.3 feet southeast of fence, 36 feet northeast of north fence corner at the crossroad to Fisher Landing, 72.6 feet from the south corner of Mrs. Tom's residence and 131 feet northwest of the west corner of a house on the opposite side of the road. The letters "U. S. P. B. M. 29" are cut on the bed rock. U. S. Deep Waterway B. M., 1899. Elevation, 83.6222 meters, 274.351 feet.

T. B. M. 170 is 1¼ miles above Fisher Landing, top of a knob on a bowlder on north side of road 2 meters south of fence, near a telegraph pole, 30 meters east of a cheese factory, and 50 meters west of a prominent angle in the road. U. S. Deep Waterway B. M., 1899. Elevation, 81.0112 meters, 265.785 feet.

P. B. M. 30 is 2½ miles below Clayton, N. Y., on top of a round-headed ¼-inch brass bolt cemented into bed rock on the north side of road opposite the property of Fetterly, 16 feet from the fence line, 144 feet west of a culvert over a dried-up creek, 43 feet east of the southeast corner of the Fox property, 277 feet west of the northwest corner of a frame house south of the road, about one-fouth mile west of a schoolhouse on top of a ridge east of the valley. The letters "U. S. P. B. M. 30" are cut on the bed rock. U. S. Deep Waterway B. M., 1899. Elevation, 80.5332 meters, 264.216 feet.

P. B. M. "A" is at Clayton, N. Y., being the center punch mark in a ¼-inch brass bolt cemented into the corner stone of water table, 6 inches from the southwest corner and on the south side of the Catholic Church, a large stone building in Clayton, N. Y. The church is on the east side of James street, 200 feet southwest of the intersection with Mary street. The bench mark is about 6 inches east of the southwest corner of the church, and the letters "U. S. A." are cut on the water table near the mark. U. S. Deep Waterway B. M., 1899. Elevation, 84.9830 meters, 278.815 feet.

P. B. M. "B" is at Clayton, N. Y., being the center punch mark in the end of a ¼-inch brass bolt cemented into the corner stone of the water table on the front of house, 8 inches from the northwest corner of the stone residence of E. C. Porter, on the east side of John street, between Jane and Hugunin streets. The letters "U. S. B." are cut on the water table. U. S. Deep Waterway B. M., 1899. Elevation, 80.5821 meters, 264.376 feet.

P. B. M. "C" is at Clayton, N. Y., being the center punch mark in the end of a ¼-inch brass bolt cemented into the stone masonry wall on the west side of stone residence of Hall B. Dewey, at the southwest corner of Hugunin and Merrick streets and one block south of the St. Lawrence River, also one block southwest of the N. Y. C. and H. R. R. R. station. The bench mark is 3.5 feet from the northwest corner of the building and 2.3 feet above the surface of the ground. The letters "U. S. C." are cut on the masonry. U. S. Deep Waterway B. M., 1899. Elevation, 79.4397 meters, 260.628 feet.

T. B. M. 179 is 2 miles above Clayton, N. Y., top of knob on a large bowlder on north side of road 100 meters north of Clark's (?) residence and 50 meters east of a cross road to the south. U. S. Deep Waterway B. M., 1899. Elevation, 97.0186 meters, 318.302 feet.

P. B. M. 31 is 3 miles above Clayton, N. Y., top of a round-headed ¼-inch brass bolt cemented into a large sandstone bowlder, which is set firmly in the ground

and is 5 feet in diameter at the surface of the ground, 52 feet south of an angle in the road. It is on the timber line at the southwest end of a clearing and about 500 feet southeast of a log cabin 3.5 feet north of a spike driven in a blaze (facing the bench mark) on a 14-inch oak tree. The letters "U. S. P. B. M. 31" are cut on the bowlder. U. S. Deep Waterway B. M., 1899. Elevation, 111.1526 meters, 364.673 feet.

T. B. M. 181 is 4 miles above Clayton, N. Y., top of knob on a large bowlder on north side of road 5 meters south of fence, 50 meters west of the residence of D. Corp and 45 meters west of a cross road to the south. U. S. Deep Waterway B. M., 1899. Elevation, 106.0667 meters, 347.987 feet.

T. B. M. 184 is 5½ miles above Clayton, N. Y., top of knob in a deep 1-inch square on a large stone of north abutment wall on east end of small stone arch bridge over a creek situated 3¾ miles northeast of Mellin Bay. The figures 184 are cut on the stone 6 inches south of the bench mark. U. S. Deep Waterway B. M., 1899. Elevation, 84.9174 meters, 278.600 feet.

P. B. M. 32 is 5½ miles above Clayton, N. Y., top of a round headed ¼-inch brass bolt cemented into bed rock, 1 meter west of the vertical ledge of rock along a creek and 46.3 meters S. 25° E. from the center of an arch bridge over the creek, 10.3 meters S. 20° W. from a 14-inch elm tree east of the creek and 11 meters N. 20° W. from an 18-inch elm west of the creek. The letters "U. S. P. B. M. 32" and two arrows pointing toward the bench mark are cut in the bed rock. U. S. Deep Waterway B. M., 1899. Elevation, 83.1710 meters, 272.870 feet.

T. B. M. 188 is 7¾ miles above Clayton, N. Y., top of a knob on a bowlder flush with the surface of the ground situated opposite Rose Bay, on the south side of road, 2 meters north of fence, 18 meters east of a culvert and 100 meters west of the residence of Jas. Liddy. U. S. Deep Waterway B. M., 1899. Elevation, 82.9233 meters, 272.057 feet.

P. B. M. 33 is 6¾ miles below Cape Vincent, N. Y., top of a round headed ¼-inch brass bolt cemented into bed rock about 800 feet east of the west end of Dodges Bay, on the north side of the road, 22 feet from the ledge of rock at the shore, 30.4 feet west of a 10-inch ash tree, 64.3 feet north from a nail driven into a blaze, facing the mark, on a maple tree situated on the fence line south of the road, 66.3 feet north of the intersection of fence along south side of road with a division line fence to the south. The letters "U. S. P. B. M. 33" and arrows pointing to the mark are cut on the bed rock which is covered slightly with earth and sod. U. S. Deep Waterway B. M., 1899. Elevation, 79.1870 meters, 259.799 feet.

T. B. M. 190 is 5¼ miles below Cape Vincent, N. Y., on top of knob on bed rock situated at Mellin Bay on south side of road 2 meters north of fence and 90 meters west of schoolhouse. U. S. Deep Waterway B. M., 1899. Elevation, 86.2320 meters, 282.913 feet.

P. B. M. 34 is 3½ miles below Cape Vincent, N. Y., top of a round headed ¼-inch brass bolt cemented into bed rock in a pasture north of road, 520 feet N. 57° E. from a large bowlder on the north fence line; bowlder is 215 feet west of 10-foot plank bridge over a dried-up creek and 344 feet west of a cross road leading south to a frame house at the foot of a hill in Hester woods, bench mark is 37 feet east from a spike in the blaze of a 12-inch elm tree. The letters U. S. P. B. M. 34 are cut on the bed rock. U. S. Deep Waterway B. M., 1899. Elevation, 79.3374 meters, 260.293 feet.

T. B. M. 194 is 3 miles below Cape Vincent, N. Y., top of knob on large bowlder on the north side of road 40 meters southwest of a prominent angle in the road and about 100 meters east of the residence of Louis Radley. U. S. Deep Waterway B. M., 1899. Elevation, 83.2677 meters, 274.088 feet.

T. B. M. 197 is 1 mile below Cape Vincent, N. Y., on top of a knob on a bowlder situated on the river side of road, on the slope of ledge about 1 meter below the level of the roadway, opposite a residence and 180 meters west of a mausoleum which is at the northwest corner of cemetery. B. M. is 60 meters east of a creek. U. S. Deep Waterway B. M., 1899. Elevation, 76.7178 meters, 251.698 feet.

P. B. M. "A" is at Cape Vincent, N. Y., being the center punch mark in the end of a ¼-inch brass rod cemented in the corner stone at the southwest corner of the United States fish hatchery (a stone building) at Cape Vincent, N. Y. The mark is on the east side of the building, 0.38 meters from the corner and 1.04 meters above the surface of the ground. The letters "U. S. A." are cut into the stone. U. S. Deep Waterway B. M., 1899. Elevation, 77.4639 meters, 254.146 feet.

P. B. M. "B" is at Cape Vincent, N. Y., on a 1-inch square smooth level surface cut on top of water table 12 inches south of the northwest corner of the Jerome House, a brick hotel situated at the northeast corner of a street intersection two blocks south of the Cleveland Seed Co.'s dock and warehouse. The let-

ters "U. S. B." are cut on the stone of the water table. U. S. Deep Waterway B. M., 1899. Elevation, 79.0871 meters, 259.472 feet.

P. B. M. "C" is at Cape Vincent, N. Y., being the center punch mark in the end of a ¼-inch brass rod cemented in the corner stone 39 inches west of the northeast corner of tower of Catholic Church, a large stone building in Cape Vincent, N. Y. The letters "U. S. C." are cut on the corner stone. U. S. Deep Waterway B. M., 1899. Elevation, 82.9560 meters, 272.165 feet.

T. B. M. 201 is 1½ miles above Cape Vincent, N. Y., top of knob on a bowlder situated on the river side of road on slope about 1 meter below the level of the roadway, 5 meters east of a cross fence to the south, and ¼ mile west of the McKinley residence. U. S. Deep Waterway B. M., 1899. Elevation, 77.6926 meters, 254.897 feet.

P. B. M. 35 is 2½ miles above Cape Vincent, N. Y., being the center punch mark in the end of a ¼-inch brass rod cemented in foundation stone on the north side of Tibbetts Point light-house tower on Tibbetts Point on the shore of Lake Ontario. The mark is 6 inches above the surface of the ground and the letters "U. S. P. B. M. 35" are cut on the foundation stone. U. S. Deep Waterway B. M., 1899. Elevation, 80.4228 meters, 263.854 feet.

Descriptions and Elevations of Bench Marks Established by the United States Lake Survey along the St. Lawrence River on the Canadian Side in 1902.

P. B. M. "L" is 1½ miles below Prescott, Canada, top of a ¼-inch brass bolt leaded vertically in east side of foundation of Windmill Point light-house. It is 29.27 feet north from the center line of east windows of tower, measurement being made around the tower, 0.7 feet above the ground, and 1 foot below water table, marked "U. S. B. M." U. S. Lake Survey B. M., 1902. Elevation, 83.3321 meters, 273.399 feet.

P. B. M. Weir is at the Galops Locks, Canada, top of a ¼-inch brass bolt leaded vertically in coping on the south side of waste weir at Galops Locks; it is 0.8 feet west of rise in wall, 1.25 feet south of the north face of the wall, 1.8 feet north of south edge of wall, and 63.8 feet northwest of northwest corner of lock house. U. S. Lake Survey B. M., 1902. Elevation, 75.9368 meters, 249.136 feet.

P. B. M. Galops is at the Galops Locks, Canada, top of a ¼-inch brass bolt leaded vertically in south coping of the lift lock. It is 27.8 feet southeast of hinge of south leaf of east gate, 3.72 feet from front face of coping, 0.3 feet from back edge of stone forming coping, and 0.3 feet from lower edge of stone. U. S. Lake Survey B. M., 1902. Elevation, 75.9621 meters, 249.219 feet.

P. B. M. 1 is at Morrisburg, Canada, the center of a ¼-inch brass bolt leaded horizontally into north and south wall at east end of new lock on the north side. It is just south of the stairs leading east from the top of the lock to the pier below, 3.9 feet above ground, 6.2 feet below the coping of the wall, 8.3 feet south of the corner under the stairs, marked

B M
1

U. S. Lake Survey B. M., 1902. Elevation, 67.3803 meters, 221.064 feet.

P. B. M. "B" is at Morrisburg, Canada, top of a ¼-inch brass bolt leaded vertically in the coping of the south wall of the canal, just west of the lock. It is 0.4 feet east of the steps to raise in coping, 0.6 feet from the north face of the wall, 6.0 feet from second corner in coping west of the west gate, marked

B M
B

U. S. Lake Survey B. M., 1902. Elevation, 69.2277 meters, 227.125 feet.

P. B. M. "A" is at Cornwall, Canada, top of a ¼-inch brass bolt leaded vertically in the fourth stone of the curved coping on the south side, running east from the head of the stairs at the east end of the lowest new lock. It is 0.63 feet south of front face of wall, 1.9 feet from rear edge of wall, 30.2 feet east of north tie rod of the south leaf of the east gate of lock, 41.97 feet north from outer corner at end of curved coping, marked

B M
A

U. S. Lake Survey B. M., 1902. Elevation, 50.9111 meters, 167.031 feet.

P. B. M. "B" is at Cornwall, Canada, top of a ¼-inch brass bolt leaded vertically in the south coping of the lowest old lock near the west reel at the east

end. It is 0.3 feet east of west edge of stone, 4.4 feet south of north face of south wall of lock, 3.45 feet from northwest leg of west reel at east end of lock, 36.05 feet southeast of hinge of south leaf of east gate of old lock, marked

B M
B

U. S. Lake Survey B. M., 1902. Elevation, 49.6487 meters, 162.889 feet.

P. B. M. "C" is at Cornwall, Canada, top of a ¼-inch brass bolt leaded vertically in coping of old lock, north of Lock No. 18. It is 0.2 feet south of north edge of coping, 4.4 feet east of west edge, 11.5 feet north of south edge of coping, 5.1 feet southwest of the most westerly electric-light pole north of the old lock, 15.95 feet from inner angle of gate recess on north side of lock, 46.2 feet from hinge of north leaf of upper gate of old lock, marked "B. M." U. S. Lake Survey B. M., 1902. Elevation, 57.3890 meters, 188.284 feet.

Zero of gage at Galops Rapids, Canada, sill of Lock No. 27. Elevation, 71.3671 meters, 234.144 feet.

Zero of gage at Morrisburg, Canada, sill of old Lock No. 23. Elevation, 63.3293 meters, 207.773 feet.

Zero of gage at Morrisburg, Canada, sill of new Lock No. 23. Elevation, 61.4830 meters, 201.715 feet.

Zero of gage at Cornwall, Canada, sill of Lock No. 15. Elevation, 43.7222 meters, 143.445 feet.

Descriptions of Bench Marks from Olcott, N. Y., to Buffalo, N. Y., Established or Connected With by Precise Levels of United States Lake Survey in 1901.

P. B. M. No. 4 is in Olcott, N. Y., on stone water table at southwest corner of a two-story brick building now owned and occupied as a general store by C. D. Shaw, on north side of street, about 200 meters west of wagon bridge over Eighteen-mile Creek; being a square cut on stone. Elevation, 79.0181 meters, 259.245 feet. Established by U. S. Deep Waterway Survey.

P. B. M. No. 5 is in Olcott, N. Y., on top of hill west of Eighteen-mile Creek, 125 meters south of main road leading north from wagon bridge over creek, on stone water table at southwest corner of a one-story schoolhouse which is built of concrete and veneered with waterworn pebbles, being a square cut on stone. Elevation, 87.2659 meters, 286.305 feet. Established by U. S. Deep Waterway Survey.

P. B. M. No. 6 is in Olcott, N. Y., on top of bridge seat at north end of west abutment of a wagon bridge over Eighteen-mile Creek, being a square cut on stone, 4 inches west and 1½ inches south of northeast corner, and marked U. □ S. Elevation, 76.1548 meters, 249.851 feet.

P. B. M. No. 3 is in Olcott, N. Y., on stone cap of foundation under west post of porch over carriage way in front of Albright Hotel, being a square cut on southeast corner of stone and marked

U S
□

Elevation, 83.5120 meters, 273.989 feet.

P. B. M. No. 2 is in Olcott, N. Y., on large stone doorsill at front entrance of the Albright Hotel, being a small square cut on west side of entrance, 1½ inches back from front edge of stone and 3 inches east of west door jamb. Elevation, 84.0379 meters, 275.714 feet.

P. B. M. No. 1 is in Olcott, N. Y., on south end of stone doorsill at front entrance to the First Universalist Church (erected in 1858), which is built of red brick and situated on the east side of the first north and south street east of Eighteen-mile Creek and about 250 meters south of the south shore of Lake Ontario, being a small square cut on front edge of stone 4 inches north of a large square on same stone, which is the old bench mark at same elevation. Elevation, 87.5711 meters, 287.306 feet. Established by U. S. Deep Waterway Survey.

T. B. M. No. 60 is about 300 meters west of New Fane Station, N. Y., on the first step above the bridge seat at the south end of the east abutment of the N. Y. C. and H. R. R. R. bridge over Eighteen-mile Creek, being the top of a square cut on southwest corner of stone step. Elevation, 95.8289 meters, 314.399 feet.

T. B. M. No. 59 is ¾ mile west of Eighteen-mile Creek, N. Y., on the north end of the west abutment of a railway bridge over Hopkins Creek on the N. Y. C. and

H. R. R. R., being the summit of a small square cut on top of stone. Elevation, 96.3152 meters, 315.994 feet.

T. B. M. No. 53 is about 1½ miles east of Wilson, N. Y., in the south root of a poplar tree 2½ feet in diameter standing on fence line on north side of east-and-west road, at east end of hedgerow and at the southwest corner of lawn in front of the residence of Mr. H. Pease, being the top of a 30d. wire nail driven into root 2½ feet south of trunk of tree. Elevation, 93.2200 meters, 305.839 feet.

P. B. M. Wilson is in Wilson, N. Y., on water table at the northwest corner of Exley Methodist Episcopal Church, being the center of a brass bolt 17 inches east, of the northwest corner, leaded horizontally and marked thus:

U S
○
P B M

Elevation, 88.3348 meters, 289.812 feet.

T. B. M. No. 47 is 4 miles east of Ransomville, N. Y., or 697 meters west of milepost 158, on the south end of the west abutment of a plate girder railway bridge over the east branch of Twelve-mile Creek on the N. Y C. and H. R. R. R., being a square cut in top of bridge seat and marked U □ S. Elevation, 95.2713 meters, 312.569 feet.

T. B. M. No. 43 is 2,650 meters east of Ransomville Station, N. Y., or 340 meters east of milepost 161, at edge of timber and on north end of west wall of open culvert on the N. Y. C. and H. R. R. R., being a square cut on stone on top of second step from top 6 inches from north and east edges of the stone, respectively. Elevation, 97.7599 meters, 320.734 feet.

P. B. M. Ransomville is in Ransomville, N. Y., on water table 20 inches west of northeast corner of brick building standing on the southwest corner of intersection of the two main streets of the village, and owned as well as occupied by W. H. H. Ransom and Son as a general store, being the top of a brass bolt leaded vertically in top of water table and marked U ⊙ S. Elevation, 99.6962 meters, 327.087 feet.

T. B. M. No. 41 is in Ransomville, N. Y., 100 meters east of the east end of Ransomville station on the south end of the west abutment of a plate girder railway bridge on the N. Y. C. and H. R. R. R.; being the top of a small square cut on the third stone step from ground, 3 inches from the south and east edges of stone step and about 6 inches below bridge seat. Elevation, 98.4499 meters, 322.998 feet.

T. B. M. No. 37 is 1,690 meters north of Model City Station, N. Y., and 225 meters north of road crossing, on flange of rail set in ground 2 meters west of track and marking the 167th milepost on the N. Y. C. and H. R. R. R.; being the top of a square cut on flange. Elevation, 100.2490 meters, 328.900 feet.

P. B. M. Model City is in Model City, N. Y., about 200 meters south of railway station in the south face of the fifth stone above ground in southeast corner of the Erie Preserving Company's warehouse, being the center of a brass bolt leaded horizontally in stone 12 inches west of corner, 30 inches above ground, and 13 inches below platform in front of building. Elevation, 110.8345 meters, 363.629 feet.

T. B. M. No. 35 is 1,892 meters southwest of Model City Station, N. Y., and just east of railroad crossing of main road leading east from Lewiston, on stone coping at north end of box culvert on the N. Y. C. and H. R. R. R., being a square cut on stone. Elevation, 126.1946 meters, 414.024 feet.

P. B. M. Lewiston is in Lewiston, N. Y., at corner of Center and Ninth streets, on the northwest corner of stone door sill of north door of west wing of old Seminary building, being a square cut on stone. Established by U. S. Deep Waterway Survey. Elevation, 122.3259 meters, 401.331 feet.

P. B. M. Lewiston Heights No. 2 is 101 meters east of the center of Lewiston Heights Station, N. Y., in face of solid rock ledge on upper side of wagon road leading down from Lewiston Heights Station to Lewiston, being the center of a brass bolt leaded horizontally in vertical face of rock, 21 inches below top of ledge and marked thus, in 3-inch letters:

U S
○
P B M

Elevation, 154.3522 meters, 506.404 feet.

T. B. M. No. 31 is in Lewiston Heights, N. Y., on top of retaining wall on south side of wagon road, 3 meters north of center of track of the N. Y. C. and H. R. R. R. and 12 meters east of northeast corner of Lewiston Heights Station, being the top of a small square cut on large stone. Elevation, 161.8245 meters, 530.919 feet.

P. B. M. Lewiston Heights No. 1 is near Lewiston Heights Station, N. Y., on a flat rock at north end of small drain under railway, approximately 30 feet in front

of north pillar of Penjerrick Gateway, which is on east side of Military road and about 200 feet south of junction with River road, being the summit of a small square cut on rock. This mark is not very permanent and is liable to be disturbed. Established by U. S. Deep Waterway Survey. Elevation, 183.1456 meters, 600.870 feet.

P. B. M. University is about 2 miles north of Niagara Falls, N. Y., and 60 meters east of top of gorge of Niagara River, in west corner of the main building of Niagara University, being the center of a brass bolt leaded horizontally into stone 4½ inches east of corner and 20 inches above ground. Elevation, 179.6347 meters, 589.352 feet.

P. B. M. Suspension Bridge is in Niagara Falls, N. Y., in the northwest corner of passinger station called "Suspension Bridge" on the N. Y. C. and H. R. R. R., being the center of a brass bolt leaded horizontally into center of seventh stone above the water table, 43 inches above the platform and 6 inches south of the northwest corner of the building. Elevation, 178.1183 meters, 584.377 feet.

T. B. M. No. 24 is in Niagara Falls, N. Y., on top of granite bowlder about the size of an oil barrel, on the west line of Sugar street, 65 meters south of the N. Y. C. and H. R. R. R. track to Lockport and 426 meters north of Ontario street, being the top of a small square cut in top of bowlder. Elevation, 183.9411 meters, 603.480 feet.

P. B. M. Echota is in Niagara Falls, N. Y., on the west end of stone doorsill of west door on south side of the N. Y. C. and H. R. R. R. station called "Echota," being the top of a small square in the southeast corner of a larger square cut on the stone. Established by U. S. Deep Waterway Survey. Elevation, 174.6271 meters, 572.922 feet.

P. B. M. Niagara No. 1 is in Niagara Falls, N. Y., on a stone 5½ inches square with a small square cut on northwest corner, now used as a reference stone for the center line of the tunnel of the Niagara Falls Power Plant, and is set in concrete in the gutter about 10 feet northwest of entrance to main building of the Niagara Falls Power Plant, 3 meters north of north door jamb and 1 meter out from building, being the top of a copper bolt leaded in the center of the stone. Elevation, 172.6838 meters, 566.547 feet.

P. B. M. Niagara No. 2 is in Niagara Falls, N. Y., on window sill of first window west of northeast corner of Niagara Falls Power Company's power house, being the top of a brass bolt leaded vertically in east end of stone, 5¼ feet from front of building, 5 inches back from front edge of window sill, 7 inches west of east side of window and on side of building facing Buffalo avenue. Elevation, 174.2931 meters, 571.827 feet.

P. B. M. Schoolhouse is in Niagara County, N. Y., on stone water table at southwest corner of brick schoolhouse in district No. 5, Niagara Township, 1 mile west of Lasalle on north side of main River road, being the top of a square cut on stone. Established by U. S. Deep Waterway Survey. Elevation, 175.3409 meters, 575.264 feet.

P. B. M. Lasalle No. 2 is in Lasalle, N. Y., on the top of water table at the southeast corner of brick residence belonging to Mr. E. H. Smith, about one-fourth mile west of the N. Y. C. and H. R. R. R. station on main road along river front, being the top of a brass bolt leaded vertically in water table. Elevation, 176.8726 meters, 580.290 feet.

P. B. M. Lasalle No. 1 is in Lasalle, N. Y., just south of Lasalle station, on the northwest corner of bridge seat of east abutment of the N. Y. C. and H. R. R. R. bridge over Cayuga Creek, being the top of a square cut on stone. Established by U. S. Deep Waterway Survey. Elevation, 174.2273 meters, 571.611 feet.

T. B. M. No. 16 is 2,625 meters north of Niagara Falls and Buffalo Electric Railway bridge over railroads and roadway, on the south root of an elm tree 28 inches in diameter, which stands alone just inside the southeast corner of small field near fence on west side of road along river front, being the top of a 20 d. wire nail driven into root. Elevation, 174.7211 meters, 573.231 feet.

P. B. M. Wheatfield is in Wheatfield Township, Niagara County, N. Y., on the south end of stone water table on east front of brick schoolhouse, which is in district No. 2, and stands on the right bank of Niagara River and on main road 510 meters below Niagara Falls and Buffalo Electric Railway bridge over railroads and wagon road, being a square cut on stone. Established by U. S. Deep Waterway Survey. Elevation, 175.7301 meters, 576.541 feet.

P. B. M. Crossing is between North Tonawanda and Lasalle, N. Y., on the northeast corner of the north foundation of the first iron trestle bent of trestle over roadway west of west pier of bridge carrying electric railway over the N. Y. C. and H. R. R. R. and the Erie Railroad and about 1 mile below city limits of North

Tonawanda, being the top of a 1-inch anchor bolt in foundation stone and marked thus: +. Established by U. S. Deep Waterway Survey. Elevation, 174.4910 meters, 572.476 feet.

P. B. M. North Tonawanda No. 2 is in North Tonawanda, N. Y., on stone water table 2 meters south of entrance to the old engine house (1873) of the Tonawanda Iron and Steel Company, situated on the right bank of the Niagara River and on the west side of Main street, being the top of a small square in the northeast corner of large square cut in corner of stone. Elevation, 176.4252 meters, 578.822 feet. Established by U. S. Deep Waterway Survey.

P. B. M. North Tonawanda No. 1 is in North Tonawanda, N. Y., on west end of granite door sill at the most eastern entrance to the front of Ascension Church on the corner of Vandervoort and Robinson streets, being the top of a square cut on top of stone. Elevation, 176.7194 meters, 579.787 feet. Established by U. S. Deep Waterway Survey.

P. B. M. Tonawanda No. 2 is in Tonawanda N. Y., on the northeast surface stone of the south abutment of the Tonawanda dam, being the top of a high point between bolted iron bars, in small square inside of large square cut on top of stone. Elevation, 175.3048 meters, 575.146 feet. Established by U. S. Deep Waterway Survey.

P. B. M. Tonawanda No. 1 is in Tonawanda, N. Y., on stone water table on west side of steeple of Christian Chapel Church, a red brick building on southeast corner of Broad and Seymore streets, being the intersection of two cross marks cut in center of large square on top of stone. Elevation, 175.6304 meters, 576.214 feet. Established by U. S. Deep Waterway Survey.

P. B. M. State Ditch is in Tonawanda, N. Y., on top of stone coping on west end of north abutment of bridge over State Ditch on Main street, 1,200 meters south of bridge over Erie Canal on Main street, being the top of a brass bolt leaded vertically in top of stone and marked thus:

U S
○
P B M

Elevation, 175.3072 meters, 575.154 feet.

T. B. M. No. 11 is in Tonawanda, N. Y., on top of stone cover of catchbasin on east side of Main street, 5 meters west of German Cemetery fence and 27 meters south of entrance to cemetery; being a square cut on top of stone 4 inches from west and south sides of stone, respectively. Elevation, 178.5900 meters, 585.924 feet.

T. B. M. No. 9 is on Military road, N. Y., on the southeast root of an elm tree 20 inches in diameter standing farthest north in a line of five trees, 12 meters west of center of electric car tracks and 180 meters north of large frame house on west side of road opposite steel ball factory at Pullman Station, being the top of a 20d. wire nail driven into root. Elevation, 184.1288 meters, 604.096 feet.

T. B. M. No. 8 is on the city limits of Buffalo, N. Y., on top of large bowlder on north side of Military road on street line 220 meters north of large saloon building at city limits and bearing the following sign in red letters on the top: "Globe Liniment is the Best," being the top of a square cut on top of bowlder 6 inches from west and south sides, respectively. Elevation, 184.0448 meters, 603.820 feet.

T. B. M. No. 7 is in Buffalo, N. Y., on the west root of an elm tree 13 inches in diameter standing 73 meters west of Military road and 145 meters south of D. L. and W. R. R. tracks, being the top of a 20d. wire nail driven into root. Elevation, 183.9787 meters, 603.603 feet.

P. B. M. St. John is in Buffalo, N. Y., on water table on the front of St. John the Baptist Church on the northwest corner of the intersection of Hertel avenue and East street, 8 inches east of east door jamb and 1 inch back from edge of water table, being the highest point in square cut on stone. Elevation, 180.4495 meters, 592.025 feet.

P. B. M. Guard Lock is in Buffalo, N. Y., in the center of coping stone on towpath side of guard lock of Erie Canal, 600 meters below International bridge over Erie Canal at Black Rock; being the highest point in small square cut in the southeast corner of larger square which is opposite the hinge of the upper gate and 7 meters below upper end of lock, marked thus: ⊡. Elevation, 175.7634 meters, 576.650 feet. Established by U. S. Deep Waterway Survey.

P. B. M. Black Rock is in Buffalo, N. Y., on top of bottom step, or sixth course of masonry below bridge seat, of south end of east abutment of bridge No. 192 over Erie Canal on Bridge street, or the first bridge over Erie Canal below the

International bridge, being the top of a brass bolt leaded vertically into top of stone 6 inches from south and west faces of stone, respectively. Elevation, 176.8503 meters, 580.216 feet.

P. B. M. International Bridge No. 2 is in Buffalo, N. Y., on a projection of stone in 4th course of masonry below bridge seat on the north end of east abutment of International bridge over main channel of Niagara River, being a square cut on stone 1.735 meters below bridge seat and 1.150 meters back of the northwest corner of abutment, the stone above being marked in white paint thus:

"U. S. B. M."
88

Elevation, 177.4727 meters, 582.258 feet. Established by U. S. Deep Waterway Survey.

P. B. M. International Bridge No. 1 is in Buffalo, N. Y., on projecting ledge of third stone from south and fifth course below bridge seat of east abutment of international bridge over Erie Canal, being the highest point of square cut on stone. Elevation, 176.7397 meters, 579.854 feet. Established by U. S. Deep Waterway Survey.

P. B. M. Waterworks is in Buffalo, N. Y., on stone window sill of center window on the river side of main building of pumping station of the Buffalo waterworks, being the center of a brass bolt leaded horizontally into stone 6 inches from north end of sill and 35 inches above the water table at the ground, marked thus:

U. S.
○
P. B. M.

Elevation, 177.6390 meters, 582.804 feet.

P. B. M. Fire Station is in Buffalo, N. Y., on water table at the northwest corner of fire-tug station at the foot of Genesee street on lake front, being the top of knob cut on corner of stone 2½ feet above the pavement. Elevation, 177.3439 meters, 581.836 feet.

P. B. M. Buffalo light-house is in Buffalo, N. Y., on plinth of most northerly Buffalo Light-house south of U. S. pier (and connected with the pier) and in line with Erie street, being the top of a high point on east corner and upper surface of plinth. Elevation, 179.8630 meters, 590.101 feet.

Descriptions and Elevations of Permanent and Temporary Bench Marks from Gibraltar, Mich., to Lexington, Mich.

U. S B M. 1877, Gibraltar, is at Gibraltar, Mich., in foundation wall of light-house tower (now abandoned and used as a dwelling) at its southeast corner, east face, in fourth course of masonry below the cut sandstone water table, being center of small hole in head of copper bolt, leaded horizontally. U. S. Lake Survey B. M., 1877. Elevation, 177.5549 meters, 582.528 feet.

P. B. M. No. 2, 1875, is at Gibraltar, Mich., on the same light-house as above (now used as a dwelling house) on the southeast corner of the stone door sill of the door in the southeast angle of the building, being marked by a right-angle cut on the stone. U. S. Lake Survey B. M., 1875. Elevation, 178.3209 meters, 585.041 feet.

P. B. M. No. 1, 1898, is at Gibraltar, Mich., in the southern part of the town on the lake front, in the rear of Mr. Edward Hall's dock and boat house, 75 feet southwest of his house, in the northeast corner of stone milkhouse, in east face, 8 inches south from corner and 4 feet 4 inches above ground, being center mark of brass bolt, leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 179.1038 meters, 587.610 feet.

T. B. M. 1 is in the northern part of Gibraltar, Mich., west of lagoon and turnpike, in base of large silver maple tree near southeast corner of Mr. Blakely's house, being the top of 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 177.4942 meters, 582.329 feet.

T. B. M. 3 is a half mile above branch of south road leading to Gibraltar, on east side of road 105 feet below Mr. Charles Laginess' front gate, on base of oak tree 2 feet in diameter; being top of 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 178.8199 meters, 586.679 feet.

T. B. M. 4 is about two miles below Trenton, Mich., on west side of south road at Riverside stock farm, north side, 7 feet east of west fence, upon lower and well-imbedded boulder, being highest point in square on stone. U. S. Deep Waterway B. M., 1898. Elevation, 175.7504 meters, 576.608 feet.

T. B. M. 5 is 1½ miles south of Trenton, Mich., in west line of south road and 14

feet north of south corner of street leading to Slocums Junction Station, on base of oak tree 16 inches in diameter; being top of 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 179.2508 meters, 588.092 feet.

U. S. B. M. Trenton is in Trenton, Mich., on the southeast corner of Washington avenue and St. Joseph street, in the northwest corner of "Commercial Hotel," in west face, 2d stone from corner, and in 1st course below water table; being center of small hole in copper bolt leaded horizontally. U. S. Lake Survey B. M., 1877. Elevation, 183.9457 meters, 603.495 feet.

P. B. M. 2 is in Trenton, Mich., on the northwest corner of St. Joseph street and Washington avenue, in stone base of store building belonging to Joseph Anderson, 5 feet 4 inches north of north side of door, and 4¾ inches south of north pillar, and 4 inches back from face; being top of brass bolt leaded vertically and marked U. S. P. B. M. U. S. Deep Waterway B. M., 1898. Elevation, 183.3995 meters, 601.703 feet.

T. B. M. 7 is ⅜ mile above "Commercial Hotel," Trenton, Mich., in field 34 feet west of west fence, on east root of elm tree 4 feet in diameter, being 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 180.3189 meters, 591.596 feet.

T. B. M. 8 is 1,312 feet below Sibley's stone quarry (crushing plant), 8 feet east of east fence on base of hickory tree 1 foot in diameter, being 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 178.6165 meters, 586.011 feet.

P. B. M. 3 is 2,525 feet above Sibley's stone quarry (crushing plant), on the north side of Mud street and 354 feet west of center of south road in foundation of F. B. Sibley's residence, in first course below base board and 1.5 feet above ground, 18.9 feet south of the northeast corner, being center of punch mark in brass bolt leaded horizontally and marked

U S
□
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 180.8872 meters, 593.461 feet.

T. B. M. 9 is 88 feet west of the Detroit, Lima and Northern R. R. track and 48 feet east of east fence of south road, also 1,080 feet above Mr. F. B. Sibley's residence, in root of large lone hollow cottonwood tree, being top 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 177.6153 meters, 582.926 feet.

T. B. M. 11, in lower part of Wyandotte. At the northwest corner of Forest street and Biddle avenue at east line of west sidewalk on top rim (immovable) of hydrant on the letter "n" of the word "open." U. S. Deep Waterway B. M., 1898. Elevation, 177.9362 meters, 583.779 feet.

Gage B. M. A. is on river bank in southern part of Wyandotte, 6 feet south of line fence between the Morton Salt Co. and Detroit Dry Dock Co. and 40 feet west of face of dock, on top of a hard-wood post 5 by 6 inches cross section, 6 inches above ground: being top of 20d spike. U. S. Deep Waterway B. M., 1898. Elevation, 176.2009 meters, 578.086 feet.

Gage B. M. B. is in Wyandotte, on River front, 42 feet south of line fence between the Morton Salt Co. and Detroit Dry Dock Co., in snubbing post: being head of large cut spike driven horizontally. U. S. Deep Waterway B. M., 1898, Elevation, 176.5544 meters, 579.246 feet.

T. B. M. 12 is in Wyandotte, Mich., on the northwest corner of Biddle avenue and Elm street at the south side of main entrance to corner store. On southeast corner of pedestal stone of pillar; being marked by two lines at right angles to each other, forming a square on corner of stone. U. S. Deep Waterway B. M., 1898. Elevation, 178.6766 meters, 586.208 feet.

P. B. M. 4 is in Wyandotte, Mich., on west side of Biddle avenue, 171 feet south of the south side of Oak street, in south pedestal stone of south pillar of brick store used as meat market, owned by J. P. Debo. It is 8½ inches east of face of building and 4½ inches north of north face of pillar; being top of brass bolt leaded vertically. Marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 178.5330 meters, 585.737 feet.

P. B. M. Wyandotte, is in Wyandotte, Mich., 2,700 feet west of Biddle avenue, on south side of Oak street, in Union School Building, on north side of foundation, in third course of masonry below the water table inclosed by fire escape wire screw; being center of small hole in head of copper bolt leaded horizontally and marked

U S
P B M

U. S. Lake Survey B. M., 1877. Elevation, 178.7297 meters, 586.383 feet.

T. B. M. 14 is 1¼ miles above Oak street, Wyandotte, Mich., on west side of Biddle avenue, in front of Dominick Dorango's house, 30 feet below north corner of yard, on Maple tree, being 20d spike in root. U. S. Deep Waterway B. M., 1898. Elevation, 178.4298 meters, 585.399 feet.

T. B. M. 15 is 260 feet south of bridge over Ecorse River, on west side of river road at upper end of Emmon's Grove at east edge of west sidewalk, on southwest root of maple tree 18 inches in diameter, leaning somewhat towards the road, being 20d wire spike. U. S. Deep Waterway B. M., 1898. Elevation, 176.2902 meters, 578.379 feet.

P. B. M. 5 is in Ecorse, Mich., on the east side of river road, at foot of Labodie street, on Mr. W. B. Smith's residence, in the east face of foundation, 10½ inches from the southeast corner, in the seventh course of brick below the base board, being center mark of brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 178.2410 meters, 584.779 feet.

P. B. M. 6 is in Ecorse, Mich., opposite the head of Fighting Island, at the Tecumseh Salt Works, 136 feet east of the northeast corner of boiler room, on the river front at the end of railroad track, 11 feet west of the bumper, and 4½ feet north of north rail, on top of pile 10 inches in diameter and 14 inches above ground; being top of 20d wire spike driven to surface and circumscribed by a 2-inch square cut into the wood. U. S. Deep Waterway B. M., 1898. Elevation, 176.3802 meters, 578.674 feet.

Gage B. M. C. is at Tecumseh Salt Works, at the north edge of evaporating shed, 42 feet west of the northeast corner, being top of a 20d spike driven in pile supporting the shed; the pile is only partly under the building. U. S. Deep Waterway B. M. 1898. Elevation, 176.1196 meters, 577.819 feet.

Gage B. M. E. is at Tecumseh Salt Works, northwest from B. M. "C," 50 feet east of northeast end of boiler room, in yard, being top of pentagonal head of hydrant. U. S. Deep Waterway B. M. 1898. Elevation, 176.6086 meters, 579.423 feet.

T. B. M. 21 is in Delray, Mich., at the intersection of the Detroit, Lima and Northern track and Rouge River, 42 feet north of track, on west bank of river, on top of large oak stump at side of oak tree, being 20d wire spike. Tree has been cut down. U. S. Deep Waterway B. M., 1898. Elevation, 178.9627 meters, 587.147 feet.

P. B. M. 7 is in Delray, Mich., at the northeast corner of River and Louis streets, on the west side of first entrance east from Louis street, on the southwest corner of pedestal stone of west pillar of doorway, being the corner of stone marked by two lines cut at right angles to each other and forming a square. U. S. Deep Waterway B. M. 1898. Elevation, 180.8436 meters, 593.318 feet.

T. B. M. 22 is in Detroit, Mich., at the northwest corner of Fort Wayne grounds at the south side of River street, on first base stone of iron fence east of high stone gatepost, on north edge of stone, being highest point inside of the square. U. S. Deep Waterway B. M., 1898. Elevation, 179.0409 meters, 587.404 feet.

P. B. M. 8 is in Detroit, Mich., at Fort Wayne, in the southwest quarter of the grounds, on the river front of building No. 60, officers' quarters, in the center of water-table course, 20 inches east from vertical center line of front of building and 3 feet and 5 inches above ground, being center of brass bolt leaded horizontally and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 183.3400 meters, 601.508 feet.

T. B. M. 23 is in Detroit, Mich., at the northwest corner of River street and Junction avenue, 10 feet west of hydrant, at side of fire box No. 815, on curbstone, being highest point in square cut in the stone. U. S. Deep Waterway B. M., 1898. Elevation, 178.5858 meters, 585.910 feet.

T. B. M. 24 is in Detroit, Mich., at the foot of Swain street, 90 feet south of the center of River street, on west stringer of dock, being top of driftbolt, circumscribed by a square cut into the timber. U. S. Deep Waterway B. M., 1898. Elevation, 176.7291 meters, 579.819 feet.

T. B. M. 25 is in Detroit, Mich., at the northeast corner of Stanton and River streets, 28 feet east of east side of brick building, in prolongation of property line, at telegraph pole on curb, being highest point in square cut in stone. U. S. Deep Waterway B. M., 1898. Elevation, 180.1034 meters, 590.890 feet.

Gage B. M. "F" is in Detroit, Mich., at the foot of Eighteenth street (not cut through), on the extreme southeast corner of foundation of roundhouse of the Pere Marquette and Detroit, Lima, and Northern railroads. U. S. Deep Waterway B. M., 1898. Elevation, 177.1404 meters, 581.168 feet.

T. B. M. 26 is in Detroit, Mich., near northeast corner of Seventh street, at No. 316–320 River street, on the building of Avery Preserving Co., on window base 17½ inches east of east face of brick pillar at entrance, being the highest point of square cut in stone. U. S. Deep Waterway B. M., 1898. Elevation, 177.5423 meters, 582.487 feet.

T. B. M. 27 is in Detroit, Mich., on the southeast corner of Wayne and Woodbridge streets, at No. 81–89 Woodbridge street, on north end of stone doorstep, 3 inches from west face of east pillar, being highest point in square. U. S. Deep Waterway B. M., 1898. Elevation, 177.3700 meters, 581.921 feet.

P. B. M. 9 is in Detroit, Mich., on the south side of Atwater street east, one block and a half east of Woodward avenue, on the office building of the City Electric Lighting Plant, on the west end of door stone of front entrance, 5 inches east of west face and 4 inches north of south face, being top of brass bolt leaded vertically and marked

U S
□
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 177.7015 meters, 583.009 feet.

T. B. M. 28 is in Detroit, Mich., on Atwater street, between St. Aubin and Dequindre streets on the southeast corner of Detroit Dry Dock Co.'s boiler shop, being the highest point in square cut in capstone of foundation. U. S. Deep Waterway B. M., 1898. Elevation, 177.3080 meters, 581.718 feet.

T. B. M. 29 is in Detroit, Mich., on the northwest corner of Mt. Elliott avenue and Wight street, 90 feet west of Mt. Elliott avenue, 2½ feet east of prolongation of east face of light-house depot, and 12 feet east of inlet, on curbstone, being highest point in square. U. S. Deep Waterway B. M., 1898. Elevation, 179.1920 meters, 587.899 feet.

U. S. B. M. Detroit is in Detroit, Mich., on the foundation of light-house depot, at foot of Mt. Elliott avenue, 8.2 feet below the outer edge of the water table, on the west door jamb of south door, being center of cross cut in the stone. U. S. Lake Survey B. M., 1871. Elevation, 178.2518 meters, 584.814 feet.

P. B. M. 10 is in Detroit, Mich., at the northeast corner of Wight street and Mt. Elliott avenue, on the north end of doorstep of west entrance to Ireland and Mathews Manufacturing Company, 5 inches from north end of step, and 3¾ inches from edge of stone, being top of brass bolt, leaded vertically, marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 180.6877 meters, 592.806 feet.

T. B. M. 30 is in Detroit, Mich., near the northwest corner of the Boulevard and Jefferson avenue, at No. 1389 Jefferson, 115 feet west of Boulevard, at the southwest corner of the building, on top stone of foundation, being highest point in square. U. S. Deep Waterway B. M., 1898. Elevation, 182.5969 meters, 599.070 feet.

T. B. M. 31 is at northwest corner of Jefferson avenue and Crane avenue, upon the curving part of curbstone, 10 inches south from Crane avenue tangent and 4 feet above telegraph pole, being highest point inside of square. U. S. Deep Waterway B. M., 1898. Elevation, 181.0699 meters, 594.060 feet.

T. B. M. 32 is at Detroit Waterworks, on the stone foundation of east gatepost of east gate of east driveway entrance from Jefferson avenue to grounds, 3 inches from pillar, being highest point in square cut on stone. U. S. Deep Waterway B. M., 1898. Elevation, 177.8201 meters, 583.398 feet.

P. B. M. 11 is in Detroit, Mich., at waterworks on standpipe tower on side facing the river on southwest end of doorstone of entrance to tower, 5 inches northeast from vertical face and 4 inches from edge of stone, being top of brass bolt, leaded vertically and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 179.0890 meters, 587.561 feet.

T. B. M. 35 is 1¼ miles above entrance to Detroit Waterworks, at Conners Creek, 50 feet north from east end of the bridge in base of the east one of four maples, being nail. U. S. Deep Waterway B. M., 1898. Elevation, 176.4589 meters, 578.932 feet.

T. B. M. 36 is 2¼ miles above entrance to Detroit Water Works, 720 feet west of Fox Creek and 100 feet west of plank walk crossing track, 8 feet north from

center of electric track on base of maple one foot in diameter, being 20d spike. U. S. Deep Waterway B. M., 1898. Elevation, 176.1557 meters, 577.937 feet.

T. B. M. 38 is at Windmill Point light-house station on center and top of concrete coping of sea wall, 27½ inches from its west end, south from keeper's house, being the highest point inside of square cut in the cement. U. S. Deep Waterway B. M., 1898. Elevation, 176.6702 meters, 579.625 feet.

P. B. M. 12 is at Windmill Point on the southwest corner of light-house keeper's house, 2 feet 5 inches east from sloping corner, in third course of masonry below water table and 3½ feet above ground, being center mark in brass bolt leaded horizontally and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 178.0705 meters, 584.220 feet.

Old B. M. "W" is at Windmill Point in foundation of light-house tower in its north by east face in 5th course of the masonry below the cut stone water table, being a horizontal groove cut in stone slab, 2½ by 1⅝ inches on face, set in flush with masonry. U. S. Lake Survey B. M., 1896. Elevation, 177.6255 meters, 582.760 feet.

T. B. M. 37 is at Grosse Pointe, Mich., 95 feet northeast of red-brick schoolhouse on east side of electric track, 15 feet northeast of "Shafer's 7-milepost" at surface of ground in brace for telegraph pole, being spike. U. S. Deep Waterway B. M., 1898. Elevation, 177.8135 meters, 583.376 feet.

P. B. M. 13 is at Grosse Pointe, Mich., "Cottage Grove post-office," on the southwest corner of Chas. Seitz's house, 7½ feet west of corner, 4½ inches below west end of stone window sill, and 2 feet 2½ inches above stonework of foundation in second course of brickwork below window sill, being center of brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 180.4664 meters, 592.080 feet.

T. B. M. 94 is top of spike in root of 24-inch maple on south side of Jefferson avenue in front of residence of Dr. Cadieux, in Grosse Pointe, five-eighths mile southwest from Country Club House. U. S. Lake Survey B. M., 1899. Elevation, 178.5194 meters, 585.692 feet.

T. B. M. 95 is top of spike on root of 30-inch sumac, 30 meters east of right-angle turn in trolley line to north, 10 meters east of Detroit, Lake Shore and Mt. Clemens Ry. waiting room at Country Club House, Grosse Pointe. U. S. Lake Survey B. M., 1899. Elevation, 182.5393 meters, 598.880 feet.

T. B. M. 96 is top of knob on northeast corner (which is highest point) of harbor line stone monument, marked Harbor Line Reference Point "b," situated at intersection of street-fence line and a property line in Gross Pointe, five-eighths mile northeast from Country Club House. U. S. Lake Survey B. M., 1899. Elevation, 179.6663 meters, 589.455 feet.

P. B. M. 35 is at Grosse Pointe Farms, Mich. It is center punch mark on ¾-inch brass bolt cemented horizontally in hole drilled in sandstone water table of Catholic church, 1.2 meters above ground, 0.7 meter west of corner, and three-fourths mile from Country Club House on Lake Shore wagon road. U. S. Lake Survey B. M., 1899. Elevation, 184.3854 meters, 604.938 feet.

P. B. M. 36 is at Grosse Pointe Farms, Mich., center punch mark on ¾-inch brass bolt cemented horizontally in hole drilled in limestone of foundation at southeast corner of "Catholic Academy of the Sacred Heart," on the face of the building 0.5 meter north of southeast corner and 0.2 meter above ground, three-fourths mile northeast from Country Club House on Lake Shore wagon road. U. S. Lake Survey B. M., 1899. Elevation, 184.7410 meters, 606.105 feet.

P. B. M. 37 is top of knob on top and near northwest side of large bowlder (1½ by 1¾ by ¾ meters) situated in front of residence of Victor Vernier, 33 meters south 40° west from the southwest corner of Lake Side House, 3¾ miles north of the Country Club House and 1½ miles south from Milk River Point on Lake Shore road. U. S. Lake Survey B. M., 1899. Elevation, 178.2111 meters, 584.681 feet.

T. B. M. 102 is top of spike on root of a 24-inch maple on west side of Lake Shore road, 140 meters north of Detroit milepost 13, at an angle in the road. U. S. Lake Survey B. M., 1899. Elevation, 178.8720 meters, 586.849 feet.

P. B. M. 38 is top of knob on southeast corner of stone monument of Lake St. Clair harbor line, marked Harbor Line Reference Point "c," situated on the prolongation of south line of east and west road and on east side of north and south road at Milk River Point. U. S. Lake Survey B. M., 1899. Elevation, 177.1167 meters, 581.090 feet.

T. B. M. 103 is top of spike on root of 30-inch poplar, on east side of road, at

Milk River Point, at turn in road to west, 18.5 meters north from P. B. M. 38. U. S. Lake Survey B. M., 1899. Elevation, 176.8491 meters, 580.212 feet.

T. B. M. 106 is top of spike on root of 18-inch maple on west side of Lake Shore road, 30 meters southeast from residence of Thomas Labodie, 3 meters south of property line cross fence to west, 2¼ miles north from Milk River Point. U. S. Lake Survey B. M., 1899. Elevation, 176.5531 meters, 579.234 feet.

P. B. M. 39 is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in foundation stone of tower of Catholic church situated at station L'Anse Creuse, on the Detroit, Lake Shore and Mt. Clemens R. R., on north buttress, 0.2 meter from corner, 0.3 meter above ground, 4¾ miles southwest from McSweeney's club house. U. S. Lake Survey B. M., 1899. Elevation, 177.0981 meters, 581.029 feet.

T. B. M. 108 is top of spike on root of 30-inch elm standing alone 20 meters east of Lake Shore road, 125 meters north of Erin schoolhouse, district No. 1, which is at motor station, Erin school, 3¾ miles southeast from McSweeney's clubhouse. U. S. Lake Survey B. M., 1899. Elevation, 176.2825 meters, 578.353 feet.

T. B. M. 111 is top of spike on root of 18-inch maple on west side of Lake Shore road, at Motor Line station, Merten, one-fourth mile southwest from Maple Grove clubhouse, 30 meters south of a vacant house. U. S. Lake Survey B. M., 1899. Elevation, 177.0307 meters, 580.808 feet.

T. B. M. 112 is top of spike on root of 40-inch poplar on west side of Lake Shore road, 175 meters north of right-angled turn in road, 60 meters south of residence of Dan. Pornnyville, seven-eighths mile southwest from McSweeney's clubhouse. U. S. Lake Survey B. M., 1899. Elevation, 177.0321 meters, 580.813 feet.

P. B. M. 40 is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in sandstone of foundation at northwest corner of Detroit, Lake Shore and Mt. Clemens R. R. power house, 200 meters west of McSweeney's clubhouse, 5 centimeters above ground, and 32 centimeters south of northwest corner. Mark on stone is

40
US

U. S. Lake Survey B. M., 1899. Elevation, 176.8542 meters, 580.229 feet.

T. B. M. 113 is top of spike on root of 30-inch elm in pasture at turn in road, 5 meters east of east road fence line, 50 meters northeast of residence of Wm. Kroll, five-eighths mile north from McSweeney's clubhouse. U. S. Lake Survey B. M., 1899. Elevation, 177.3116 meters, 581.729 feet.

P. B. M. 41 is center punch mark on ¼-inch brass bolt cemented horizontally in hole drilled in sandstone water table on the west side of brick residence of J. Reimold, 1 mile east of Mt. Clemens, Mich., on south bank of Clinton River, 0.9 meter above surface of ground, 0.7 meter north of bay window. U. S. Lake Survey B. M., 1899. Elevation, 180.1916 meters, 591.179 feet.

T. B. M. 117 is top of spike on root of 12-inch maple on west side of Sugar Bush road, 1 mile north of the residence of J. Reimold, which is on the Clinton River, in west fence line. U. S. Lake Survey B. M., 1899. Elevation, 177.8790 meters, 583.592 feet.

T. B. M. 119 is top of spike on root of 14-inch elm on Sugar Bush road, 50 meters north of residence of Sextus Frink, 2¼ miles north from Clinton River, one-half mile south of town line. U. S. Lake Survey B. M., 1899. Elevation, 178.1521 meters, 584.488 feet.

T. B. M. 122 is top of spike on root of 12-inch maple on west fence line of Sugar Bush road, 25 meters south of Schumaker's road to west, 50 meters northwest from residence of Ed. Tucker, 1⅛ miles north from town line. U. S. Lake Survey B. M., 1899. Elevation, 179.9102 meters, 590.256 feet.

T. B. M. 124 is top of spike on root of 24-inch cherry on east side of Sugar Bush road, opposite residence of David Furnant, 70 meters south of an angle in road to west, 2¼ miles north from town line. U. S. Lake Survey B. M., 1899. Elevation, 179.0167 meters, 587.324 feet.

T. B. M. 126 is top of spike on root of 15-inch elm on east fence line of Sugar Bush road, 60 meters south of angle in road, opposite residence of Mitchel Pelkey, 3¼ miles west from New Baltimore, Mich. U. S. Lake Survey B. M., 1899. Elevation, 179.2038 meters, 587.938 feet.

T. B. M. 127 is top of knob on concrete on top of south end of west abutment of the 4-meter bridge over west branch of Salt River, 2½ miles west from New Baltimore, on Sugar Bush road. U. S. Lake Survey B. M., 1899. Elevation, 176.6566 meters, 579.581 feet.

P. B. M. 34 is in southwest end of New Baltimore, Mich., on the northwest side of Main street, in the front face of foundation of house owned by heirs of Edward

Rose, 7 inches west of cellar window and 5 inches below water table, being center mark of brass bolt leaded horizontally marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 179.9101 meters, 590.255 feet.

T. B. M. 93 is in New Baltimore, Mich., 2,300 feet below Washington street, on the southwest side of road, in fence line, just south of Ed. Rose's house, on base of willow tree 18 inches in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.1664 meters, 584.534 feet.

P. B. M. 33 is in New Baltimore, Mich., at the southwest corner of Main and Washington streets on the corner building owned by William Baker, north side, in the window base of west window, 9 inches east of west end of stone and 4 inches from its front edge, being top of brass bolt leaded vertically and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 179.4094 meters, 588.612 feet.

P. B. M. 32 is in New Baltimore, Mich., about 1,900 feet above Washington street, on east side of Main street, at the northwest corner of Henry C. Schnoor's residence, in water table, 6 inches east of its west end, being center mark of brass bolt leaded horizontally and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 182.9038 meters, 600.077 feet.

T. B. M. 92 is in the north limits of New Baltimore, Mich., 345 feet south of crossing of Detroit and River St. Clair Railroad, just east of east road fence, on base of maple tree, 20 inches in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 180.4779 meters, 592.118 feet.

T. B. M. 91 is 1¼ miles west of Anchorville, Mich., about a quarter mile west of Mr. Wendler's farmhouse and 85 feet west of small bridge over gully, at the south side of the Detroit and River St. Clair Railroad, on base of the lone elm tree, 16 inches in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.6854 meters, 586.237 feet.

T. B. M. 89 is 1¼ miles east of Anchorville, Mich., on north side of road, just north of fence in front of Thomas Beauvais's house, on base of lone cottonwood tree 3 feet in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.3935 meters, 585.279 feet.

T. B. M. 87 is 275 feet west of Swan Creek, on south side of road, on base of 3rd willow tree west of Fair Haven Stave Company's store, tree is about 14 inches in diameter, being 20d spike with washer. U. S. Deep Waterway B. M. 1898. Elevation, 175.8170 meters, 576.826 feet.

P. B. M. 31 is 1 mile west of Fair Haven, Mich., and about a half mile east of Swan Creek, at the southwest corner of Mrs. C. Rose's house, south face, in the foundation, fourth course above-ground, second course below water table, being center of brass bolt, leaded horizontally and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 177.9445 meters, 583.806 feet.

T. B. M. 86 is 1 mile west of Fair Haven, Mich., on the lake front, on north side of road, on base of maple tree 1 foot in diameter, southwest from the front door of Mrs. C. Rose's house, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.2005 meters, 581.365 feet.

P. B. M. 30 is in Fair Haven, Mich., at Henry C. Schnoor's stave mill, in the south face of brick chimney near the boiler-room door, in the tenth brick east from west face and in the Twenty-second course of brick above the ground, being center mark of brass bolt, leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation 177.8502 meters, 583.497 feet.

T. B. M. 84 is at Fair Haven, Mich., on south side of road about 30 feet west of Joseph Porea's house on base of large willow tree just east of small creek, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 176.3621 meters, 578.615 feet.

T. B. M. 82 is 1¼ miles east of Fair Haven, Mich., 375 feet south from corner where road turns west to Fair Haven, on west side of road about 8 feet east of west

fence, on base of lone oak tree 18 inches in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.1259 meters, 581.121 feet.

T. B. M. 81 is 1¾ miles east of Fair Haven, Mich., 1,180 feet east of Bouvier Creek, in field, 50 feet north of north fence, opposite burnt snag of a tree, on root of lone oak, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 176.3990 meters, 578.736 feet.

T. B. M. 77 is 3 miles west of Algonac, Mich., on west side of road in the northeast corner of wheat field of Claus Sleeter, on base of oak tree, being 20d spike and washer. U. S. Deep Waterway B. M., 1898. Elevation, 181.3208 meters, 594.884 feet.

T. B. M. 75 is 1¼ miles west of River st., Algonac, Mich., 170 feet west of fork of back road to Marine City, on south side of road, 3 feet south of fence, in base of large lone oak tree, being 20d spike in root. U. S. Deep Waterway B. M., 1898. Elevation, 178.6580 meters, 586.147 feet.

T. B. M. 74 is one-half mile west from River st., Algonac, Mich., at cemetery, 3 feet south of south fence, in first black-oak tree east of steps to cemetery, in base of tree, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.3229 meters, 585.048 feet.

P. B. M. 29 is in Algonac, Mich., in the foundation of public school at the northeast corner of east wing, in north face of corner stone, being center mark of brass bolt, leaded horizontally and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 178.2781 meters, 584.901 feet.

P. B. M. 28 is in Algonac, Mich., in the foundation of the town hall, on its east face, sixth brick south from the northeast corner and in the eighth course of brick above stone foundation, being center mark of brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 178.3538 meters, 585.149 feet.

Gauge B. M. "R" is in Algonac, Mich., on northwest corner of River and Smith streets, on foundation of Mr. Moore's house, south side, 2d stone west from southeast corner (2.6 feet). U. S. Deep Waterway B. M., 1898. Elevation, 178.3580 meters, 585.162 feet.

T. B. M. 73 is in Algonac, Mich., at northeast corner of Smith and River streets, in front of J. A. Smith's house, on east root of elm tree, 3 feet in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.4491 meters, 582.180 feet.

T. B. M. 71 is 1¼ miles below Roberts Landing, Mich., on east edge of road, 230 feet below dock to "Grummonds Grove," on base of hickory tree 2 feet in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.1608 meters, 581.235 feet.

T. B. M. 70 is about half a mile below Roberts Landing, Mich., 40 feet south of lane running west, between road and O'Leary's barn, on base of lone hickory tree 2 feet in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.5702 meters, 582.579 feet.

P. B. M. 27 is a half mile north of Roberts Landing on the river front, on the house owned by D. B. Shier and A. S. Freeman, on the north face in the corner brick at the northwest corner of kitchen, in the sixteenth course above ground, being center mark in brass bolt, leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 178.3699 meters, 585.202 feet.

T. B. M. 67 is about 2½ miles below Bell River bridge, Marine City, 40 feet east of east road fence in Mr. Wm. Cottrell's orchard, on base of southwest tree, being 20d. wire spike and washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.6406 meters, 582.809 feet.

T. B. M. 64 is about a half mile below Bell River bridge, Marine City, Mich., on west side of River road, in front of Mr. J. Wonsey's house, on base of 2nd tree north of front gate, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.2484 meters, 584.804 feet.

P. B. M. 26 is in Marine City, Mich., on the southeast corner of Water and Union streets, in the Marine City Stave Company's store, near northwest corner, on stone base under window, 8 inches south of north end and 2½ inches from front edge, being top of brass bolt, leaded vertically and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 178.7523 meters, 586.457 feet.

Gauge B. M. "P" is in Marine City, Mich., on the Backus Block, on the north

side of doorsill of the bank of G. W. and F. T. Moore, being marked by a cross. U. S. Deep Waterway B. M., 1898. Elevation, 178.7544 meters, 586.464 feet.

Gauge B. M. "O" is in Marine City, Mich., on the southeast corner of Washington and Water streets, on the northwest corner of stone foundation of building occupied by the "Globe" office, 2 feet below wood of building and 6 inches above ground, being marked by a square. U. S. Deep Waterway B. M., 1898. Elevation, 177.7407 meters, 583.138 feet.

P. B. M. 25 is in Marine City, Mich., at northwest corner of Main and Broad streets, on the city hall, near its southeast corner, at the window entrance to corridor, 2 feet 5 inches above ground and 5 inches south of the north jamb, being the top of a brass bolt leaded vertically and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 179.2712 meters, 588.159 feet.

T. B. M. 63 is in Marine City, Mich., on the northwest corner of Main and Jefferson streets, on base of large maple tree, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.7808 meters, 586.550 feet.

P. B. M. 24 is in Marine City, Mich., in west face of city waterworks building, 5 inches north of the southwest corner and 2½ feet above ground, being center mark of brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 179.7864 meters, 589.849 feet.

T. B. M. 62 is at the upper end of Marine City, Mich., on the west side of Main street, in front of Peter Francis' house, on base of maple tree 2 feet in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 178.0924 meters, 584.291 feet.

T. B. M. 61 is 1¼ miles above Broad st., Marine City, on east edge of road at top of river bank, opposite Charles Holland's house, on base of poplar tree about 1 ft. in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.8558 meters, 583.515 feet.

T. B. M. 59 is at Recors dock, on north side of road, 278 feet west of corner of fence where road turns abruptly towards the west, on base of maple tree 10 inches in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 177.7393 meters, 583.132 feet.

P. B. M. 23 is in East China, Mich., a half mile above Ricors dock on river front, in foundation of Rankin's house, south side, between kitchen and cellar door, 26 inches east of east kitchen door jamb, 7¾ inches below weather board and 18 inches above ground, being center mark of brass bolt leaded horizontally, marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 180.0894 meters, 590.843 feet.

T. B. M. 57 is opposite East China schoolhouse, on river bank, on base of large lone oak, being 20d wire spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 180.7886 meters, 593.137 feet.

T. B. M. 55 is 1¾ miles below St. Clair waterworks, 60 feet below (east of) large angle in road and 9 feet south of south road fence, in base of pine tree 2 feet in diameter, being 20d spike. U. S. Deep Waterway B. M., 1898. Elevation, 180.8506 meters, 593.340 feet.

T. B. M. 54 is in south end of St. Clair, on west side of front street opposite Oakland Hotel, just south of row of cottages, on base of oak tree 3 feet in diameter, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 185.4207 meters, 608.334 feet.

P. B. M. 22 is in St. Clair, Mich., lower part of town, on river front at John Schlinkert's coal yard, in brick wall of "old storehouse," 7¼ inches north from the southeast corner, 4.1 feet above ground and in the twenty-first course of brick below woodwork of gable, being center of mark in brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 182.7817 meters, 599.676 feet.

Gauge B. M. "N" is in St. Clair, Mich., on south side of Adam street on north side of Barron building, used as post-office, on stone window sill of east window in basement, 1 foot west of east edge of sill, being marked by a square. U. S. Deep Waterway B. M., 1898. Elevation, 177.9511 meters, 583.828 feet.

Gauge B. M. "M" is in St. Clair, Mich., at foot of Adam street, at the southwest corner of Schwabins Bros.' saloon, on corner of water table, being marked by a square. U. S. Deep Waterway B. M., 1898. Elevation, 179.4537 meters, 588.758 feet.

P. B. M. 21 is in St. Clair, Mich., at the city waterworks, 5 feet 7½ inches south of south end of doorstone at main entrance, in water table, being top of brass bolt leaded vertically and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 179.4688 meters, 588.807 feet.

P. B. M. 20 is in St. Clair, Mich., on top of north hill, on west side of Front street, in the foundation of Mr. Mark Hopkins' residence, in the east face, in second stone south of the northeast corner, top course of masonry, being center mark in brass bolt leaded horizontally, marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 191.2007 meters, 627.298 feet.

T. B. M. 53 is in St. Clair, Mich., on top of hill above center of town, on west side of Front street just east of sidewalk, on second maple tree, 2 feet in diameter, north of Mark Hopkins' north fence, being 20d spike and washer. U. S. Deep Waterway B. M., 1898. Elevation, 189.9800 meters, 623.293 feet.

T. B. M. 52 is 1¼ miles above St. Clair, Mich., on east side of River street near river bank, opposite Hotel Summerville, on base of lone elm tree, 3 feet in diameter, being 20d spike (wire) and washer. U. S. Deep Waterway B. M., 1898. Elevation, 186.0075 meters, 610.259 feet.

T. B. M. 49 is 3 miles above St. Clair, Mich., just above "Oak Grove," on east side of river road, where it turns from river below little bridge, on south bank of gully, in base of oak tree, 2 feet in diameter, being 20d spike and washer. U. S. Deep Waterway B. M., 1898. Elevation, 184.7762 meters, 606.220 feet.

T. B. M. 48 is 1½ miles below Marysville, Mich., 390 feet south of little bridge over gully which is just at lower side of house owned by Mr. Westcott and occupied by Barbour, 15 feet east of east fence of river road, and 25 feet west of river bank, on base of lone oak tree, 2 feet in diameter, being top of a 20d spike. U. S. Deep Waterway B. M., 1898. Elevation, 180.5901 meters, 592.486 feet.

T. B. M. 47 is 1 mile below Marysville, on west side of river road, 3 feet west of road fence, at Mr. Carlton's house, on seventh locust tree from upper end of row, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 181.0063 meters, 593.852 feet.

Gauge B. M. "L" is in Marysville, Mich., on lower one of three tall chimneys, shingle mill chimney, on top of the northwest corner of stone foundation, about one foot below surface of ground, being highest point in square. U. S. Deep Waterway B. M. 1898. Elevation, 177.6254 meters, 582.760 feet.

P. B. M. 19 is in Marysville, Mich., diagonally opposite Marysville Hotel, in foundation of N. B. Mills' store, in second brick east from west corner and in seventh course above stone foundation, being center mark in brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 179.8364 meters, 590.013 feet.

P. B. M. 18 is in Marysville, Mich., at the upper mill (Sanburn sawmill), on chimney bearing stone marked 1871 in west end, south face in corner brick, seventeenth course above the foundation, being center mark in brass bolt leaded horizontally. U. S. Deep Waterway B. M., 1898. Elevation, 178.9675 meters, 587.163 feet.

T. B. M. 46 is three-fourths mile above Marysville, Mich., 195 feet north of small bridge over gully, 130 feet above square frame house, on base of large oak tree, stones piled around it, being 20d spike with washer. U. S. Deep Waterway B. M., 1898. Elevation, 180.8145 meters, 593.222 feet.

T. B. M. 45 is on south bank of Bunce Creek, 325 feet from river bank of St. Clair River, just north of road fence, on lone pine tree, 18 inches in diameter, 20d spike in root. U. S. Deep Waterway B. M., 1898. Elevation, 180.9675 meters, 593.724 feet.

T. B. M. 44 is 650 feet below intersection of river road with road to Smiths Creek, called "wooden track," 55 feet east of river road on base of large lone elm tree, being 20d spike through washer in root. U. S. Deep Waterway B. M., 1898. Elevation, 181.8323 meters, 596.562 feet.

Gauge B. M. "J" is 2¾ miles below Black River at the Hamilton place, on west side of river road, about 250 feet below the house, being highest point of hydrant. U. S. Deep Waterway B. M., 1898. Elevation, 181.7790 meters, 596.387 feet.

T. B. M. 43 is 3,420 feet below dry dock, 520 feet above the Hamilton place, and 164 feet above road running west from river road, on west side of river road, in

base of pine tree, 1 foot in diameter, being 20d spike. U. S. Deep Waterway B. M., 1898. Elevation, 181.2717 meters, 594.723 feet.

T. B. M. 42 is 2¼ miles below Black River, Port Huron, Mich., on top of river bank, east of river road, 900 feet below brick chimney at the dry dock, on base of large lone oak tree, being 10d nail. U. S. Deep Waterway B. M., 1898. Elevation, 181.5300 meters, 595.570 feet.

P. B. M. 17 is about 2 miles below Black River, Port Huron, Mich., at Alverson and Dunford's dry dock, in south face of the boiler house of pumping station, in top course of stone foundation, 10 inches west from west face of coal door and 6 inches below top of stone, being center mark of brass bolt leaded horizontally, marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 181.8824 meters, 596.726 feet.

T. B. M. 41 is in Port Huron, Mich., 1⅜ miles below Black River, and 1,840 feet below the viaduct over Flint and Pere Marquette Railroad, at the west side of Military street, in front of No. 2409, 12 feet north of horse block, being highest point inside of square on curb. U. S. Deep Waterway B. M., 1898. Elevation, 183.9580 meters, 603.536 feet.

T. B. M. 40 is in Port Huron, Mich., about three-fourths mile below Black River, on west side of Military street, in front of No. 1915, at south side of carriage walk to street on curb, being highest point inside of square. U. S. Deep Waterway B. M., 1898. Elevation, 184.6184 meters, 605.702 feet.

Gauge B. M. "I" is in Port Huron, Mich., at foot of Clyde street about 100 feet from river, on brick powder house, being top of lower hinge bolt. U. S. Deep Waterway B. M., 1898. Elevation, 178.4186 meters, 585.361 feet.

P. B. M. 16 is in Port Huron, Mich., 290 feet south of Black River, on west side of Military street, on the Opera House block, at center post of front entrance on the extreme southeast corner of iron plate, being surface inside of 1 inch square. U. S. Deep Waterway B. M., 1898. Elevation, 181.4373 meters, 595.265 feet.

P. B. M. 15 is in Port Huron, Mich., on court-house, on the stone doorstep of the northeast basement door, 4½ inches south of south jamb and 3¼ inches from front edge, being top of brass bolt leaded vertically, marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 182.7035 meters, 599.420 feet.

P. B. M. 14 is in Port Huron, Mich., at city waterworks, at the south end of coal shed, 66 feet south of south face of main building, on coping stone of the south retaining wall, 6 inches from its south face and 6 inches from its east end, at which point wall of south end of coal shed rises vertically 3 feet to upper coping, being top of brass bolt leaded vertically and marked

U S
P B M

U. S. Deep Waterway B. M., 1898. Elevation, 182.9235 meters, 600.142 feet.

B. M. Fort Gratiot Light-house, 1877, is at foot of Lake Huron, 2¼ miles above Black River, Port Huron, Mich., at Fort Gratiot Light-house, in south foundation wall of brick dwelling of light-house in upper course of masonry, 2.1 feet from southeast corner and 0.6 foot below the water table, being center of small hole in head of copper bolt leaded horizontally. U. S. Lake Survey B. M., 1877. Elevation, 179.9367 meters, 590.342 feet.

T. B. M. 62 is at Fort Gratiot, Mich., summit of a small square cut on foundation of oil house at Fort Gratiot Light-house. The oil house is a round building, and the mark is on the south side about 3 inches north of south edge of cement foundation and 7 inches from south side of building. U. S. Lake Survey B. M., 1901. Elevation, 178.8920 meters, 586.915 feet.

T. B. M. 63 is 1¼ miles north of Fort Gratiot, Mich., top of a 30d wire nail driven in the northwest root of a 2-foot Lombardy poplar tree, which is the center one of a line of three, all about the same size and lying northeast and southwest in direction; B. M. is 30 meters south of the southeast corner of Huronia Beach Hotel, 30 meters east of car track; track is on the west side of wagon road from Port Huron, Mich., to Lakeport, along the lake. U. S. Lake Survey B. M., 1901. Elevation, 179.7774 meters, 589.820 feet.

T. B. M. 67 is 5 miles north of Fort Gratiot, Mich., top of a 30d wire nail driven in the east root of a large pine stump. It is 3 meters west of center of wagon

road, 5 meters east of north and south fence on west side of road, 390 meters north of a small creek which crosses the road, known as Thompsons Ditch, one-eighth mile west of Lake Huron. U. S. Lake Survey B. M., 1901. Elevation, 180.4684 meters, 592.087 feet.

T. B. M. 68 is 5½ miles north of Fort Gratiot, Mich., top of a 30d wire nail driven in the east root of a 10-inch elm tree which stands 4 meters south of Gilbert Creek and 5 meters west of the center of wagon road along west side of Lake Huron from Port Huron to Lakeport, Mich. U. S. Lake Survey B. M., 1901. Elevation, 179.4494 meters, 588.744 feet.

T. B. M. 69 is 2 miles south of Lakeport, Mich., top of a 30d wire nail driven in the east root of a 10-inch elm tree which stands 3 meters west of center of wagon road and 5 meters east of north and south fence on west side of road from Port Huron to Lakeport. It is 35 meters north of a point in road directly west of Mr. Sterling's barn, which stands about 100 meters east of road. U. S. Lake Survey B. M., 1901. Elevation, 181.0850 meters, 594.110 feet.

T. B. M. 71 is one-fourth mile south of Lakeport, Mich., top of a 30d wire nail driven in the west root of a 2½-foot white pine tree, which is the north one of two large white pine trees standing in the wagon road. Tree stands about 10 meters east of north and south fence on west side of the road and about 15 meters west from top of bank of Lake Huron. U. S. Lake Survey B. M., 1901. Elevation, 182.1840 meters, 597.715 feet.

P. B. M. Lakeport is in Lakeport, Mich. It is the top of a brass bolt leaded vertically in the top of a granite stone, 14 inches by 14 inches by 8 inches, buried 2½ feet under ground, in the southeast corner of lot No. 2, block 2. It is in the southeast corner of hotel yard owned by Mr. John Thoday, 20 inches north of fence on north side of Milwaukee street and 14 inches west of fence on west side of Second street. A granite stone, 6 inches by 6 inches, extends 4 inches above the ground and is directly over P. B. M. U. S. Lake Survey B. M., 1901. Elevation, 181.4931 meters, 595.449 feet.

T. B. M. 74 is 2 miles north of Lakeport, Mich., on top of a 30d wire nail driven in the west root of a 12-inch willow tree standing 4 meters east of center of State road. Tree forks about 7 feet above the ground and is blazed 4 feet above ground with a small triangle facing road. There is a grove of young timber on the west side of the road. U. S. Lake Survey B. M., 1901. Elevation, 188.0385 meters, 616.923 feet.

T. B. M. 79 is 5 miles north of Lakeport, Mich., top of a 30d wire nail driven in the northeast root of a 10-inch elm tree which stands east of north and south fence on west side of State road, 150 meters north of a creek which crosses the road 5 miles from Lakeport, Mich., and 6½ miles south of Lexington, Mich.; tree stands in front of Mr. John Tolle's house. U. S. Lake Survey B. M., 1901. Elevation, 191.0972 meters, 626.958 feet.

T. B. M. 83 is 5 miles south of Lexington, Mich., top of a 30d wire nail driven in the west root of a 12-inch ash tree which stands 1 meter east of north and south fence on west side of State road. It is 35 meters north of a white birch tree which stands near the fence, 275 meters north of intersection of roads running north and south and east and west, 6½ miles from Lakeport, Mich. U. S. Lake Survey B. M., 1901. Elevation, 190.4417 meters, 624.807 feet.

T. B. M. 84 is 4¼ miles south of Lexington, Mich., top of a 30d wire nail driven in the west root of a 15-inch black locust tree which stands 2 meters east of north and south fence on west side of State road. There is a 15-inch elm standing 1 meter east of fence on east side of road and almost directly opposite. A thick growth of young timber stands on east side of road one-fourth mile south. U. S. Lake Survey B. M., 1901. Elevation, 191.1417 meters, 627.104 feet.

T. B. M. 85 is 3¾ miles south of Lexington, Mich., top of a 30d wire nail driven in the west root of a 3-foot willow tree which stands 3 meters west of north and south fence on west side of State road, 475 meters south of Mill Creek. Tree stands in Mr. Willard Wurden's front yard. U. S. Lake Survey B. M., 1901. Elevation, 193.0065 meters, 633.222 feet.

T. B. M. 86 is 3½ miles south of Lexington, Mich., top of a bolt at the north end of west side of a small steel wagon bridge over Mill Creek. Bolt is over the west end of north abutment and is the most northerly one in a row of six on the west side of the bridge. U. S. Lake Survey B. M., 1901. Elevation, 184.3163 meters, 604.711 feet.

T. B. M. 88 is 1½ miles south of Lexington, Mich., top of a 30d wire nail driven in the west root of a 16-inch elm tree which stands 1 meter west of north and south fence on east side of State road, 50 meters southwest of Mr. Stewart's house, and 15 meters south of a large white birch tree on same side of the road. U. S. Lake Survey B. M., 1901. Elevation, 189.9410 meters, 623.165 feet.

P. B. M. 1 is in Lexington, Mich., center of a period between the letters M. and E. in the center of the corner stone of the M. E. Church at Lexington, Mich. Church stands on the northeast corner of Main and Lake streets, and was rebuilt in 1890. Mark is about 3 feet above ground, 9 inches north of the southwest corner. Corner stone marked:

FIRST
M. E.
CHURCH
1851-1890

U. S. Lake Survey B. M., 1901. Elevation, 190.0419 meters, 623.496 feet.

P. B. M. Lexington No. 2 is in Lexington, Mich. It is the summit of a small square cut on top of water table on west side of a two-story brick building, owned by John L. Fead, at the northeast corner of Main and Boynton streets. Mark is 25 inches north of southwest corner of building and 3 inches back from front of water table. U. S. Lake Survey B. M., 1901. Elevation, 188.8642 meters, 619.632 feet.

P. B. M. Lexington No. 3 is in Lexington, Mich. It is the summit of a brass bolt leaded vertically in the north end of stone doorsill of the north door of City Hall. Bolt is 3 inches south of north end of sill and 1½ inches back of front edge. It is about 10 feet south of the northwest corner of building. Building is a three-story brick and fronts on Main street between Huron avenue and Simons street. Ground floor used for hose house, second floor for council room, and third floor for Masonic Hall. U. S. Lake Survey B. M., 1901. Elevation, 189.7876 meters, 622.661 feet.

P. B. M. Lexington No. 4 is in Lexington, Mich. It is the summit of a brass bolt leaded vertically in the top of a large granite bowlder which is in the front yard of Mrs. Martha Henry's property. It is 22 meters north of the north end of Dallas street and the north side of Simons street (foot of street is at dock). It is about 40 meters back from high bank of lake and about 125 meters south of the Lexington Woolen Mills. U. S. Lake Survey B. M., 1901. Elevation, 186.7946 meters, 612.842 feet.

DESCRIPTIONS AND ELEVATIONS OF PERMANENT AND TEMPORARY BENCH MARKS ALONG THE ST. MARYS RIVER FROM DETOUR, MICH., TO IROQUOIS POINT, MICH.

P. B. M. boathouse is at Detour, Mich., top of a brass bolt leaded vertically in the top of a limestone bowlder 1 meter by 1½ meters and projecting about 0.3 meter above the ground. Bowlder is well embedded and lies on gravel beach on the east shore of the bay and on the west side of Detour Point. It is 65 meters north of boathouse belonging to Detour light-house, 74 meters northeast of outer end of pier at boathouse, 3 meters east of water's edge, 7 meters west of edge of brush, and 300 meters from Detour light-house. Bolt is about 6 inches from north edge of bowlder. Marked U. S. U. S. Lake Survey B. M., 1901. Elevation, 177.4475 meters, 582.176 feet.

P. B. M. Detour No. 5 is at Detour, Mich., top of a brass bolt leaded vertically in the top of a large limestone bowlder which lies 11 meters northwest of the northwest corner of the light keeper's dwelling. The bowlder is well embedded and projects about one-half meter above the ground. The bolt projects about one-fourth inch above the bowlder. Old name of B. M. was "Detour Point No. 2." Marked U. S. U. S. Lake Survey B. M., 1901. Elevation, 179.9727 meters, 590.460 feet.

P. B. M. Detour No. 4 is at Detour, Mich., top of a brass bolt leaded vertically in the summit of a very large limestone bowlder, which lies 5 meters north and 1½ meters east of the northwest corner of the tower of Detour light-house. The stone is marked thus:

'S 'n
+
P. B. M.

the bolt being on the western point of the cross which is an old T. B. M. U. S. Lake Survey B. M., 1901. Old name of B. M. was "Detour Point" No. 1. Elevation, 181.3490 meters, 594.976 feet.

P. B. M. Detour No. 3 is at Detour, Mich., intersection of a cross cut on top of iron plate about 6 inches northwest of the northwest corner post of Detour light-house. Old name of B. M. was "Detour Light." Marked U. S. + B. M. U. S. Lake Survey B. M., 1895. Elevation, 180.2159 meters, 591.258 feet.

T. B. M. 196 is at Detour Point, Mich., on top of a small square cut on top of an embedded limestone bowlder which lies at the northeast corner of the residence at Detour light-house and projects about 5 inches above ground. B. M. is 1 meter

north and 3 meters west of the northeast corner of the house and about 3 meters from the northwest corner of the tower. U. S. Lake Survey B. M., 1901. Elevation, 180.0510 meters, 590.717 feet.

P. B. M. Goetz is at Detour, Mich., top of a brass bolt leaded vertically in the top of a granite bowlder near the center of the foot of St. Marys street, about 35 meters from the water's edge of St. Marys River, and projecting about 5 inches above the ground. The bowlder is 7 meters south and 1½ meters east of the corner of the sidewalk, one block north of Anthony's dock, 70 meters east and 8 meters south of the southwest corner of Hotel Detour, owned by J. F. Goetz. U. S. Lake Survey B. M., 1901. Elevation, 183.6017 meters, 602.367 feet.

P. B. M. Detour No. 2 is at Detour, Mich., top of an iron bolt 1¼ inches square cemented in the top of a granite bowlder, the top of which is about flush with the ground, 85 meters east and 20 meters south of the Huron House, 55 meters south of Bennett's store and post-office, 17 meters from water's edge of St. Marys River, 24 meters northeast of the northeast corner of J. T. Bennett's yard near Anthony's coal dock. Old name of B. M. was "Detour G." U. S. Lake Survey B. M., 1895. Elevation, 178.7748 meters, 586.530 feet.

P. B. M. Terrett is at Detour, Mich., top of a brass bolt leaded vertically in top of a large limestone bowlder which lies at the junction of Superior and Huron streets, about 2 meters west of the east line of Superior street and at a point where Superior street angles to the west. It is 8 meters northwest of a large granite bowlder, 17½ meters east of a fence corner which is the southeast corner of a block, also southeast corner of Mr. Richard Terrett's yard, 26½ meters southeast of the northeast corner of Mr. Terrett's house, 22 meters northeast of a log house, 80 meters northwest from the water's edge of St. Marys River, and one block (130 meters) south of P. B. M. Detour No. 1. Marked

U S
P B M

U. S. Lake Survey B. M., 1901. Elevation, 182.7885 meters, 599.699 feet.

P. B. M. Detour No. 1 is at Detour, Mich., top of a ½-inch iron bolt leaded vertically in the top of a cut stone, 6 inches by 6 inches by 20 inches, and buried 2½ feet below the surface of the ground, at the intersection of Superior and Drummond streets. It is 4 meters north and 3 meters east of a fence corner at the southeast corner of street intersection. A cedar post 6 inches in diameter and 4 inches by 4 inches at the top is planted over the bench for a surface mark and projects about 3 feet above ground. Letters "U. S. B. M." are cut on opposite sides of the post. Old name of B. M. was "Detour." U. S. Lake Survey B. M., 1895. Elevation, 186.5005 meters, 611.877 feet.

T. B. M. 190 is 2¼ miles west of Detour, Mich., on summit of a small square cut on the top of a limestone bowlder embedded in the bank on the south side of the county road. Bowlder is 25 meters east of the crest of a large hill and 11 meters east of a very large limestone bowlder lying on the north side of the road. The square is 2 feet back from the front edge of the bowlder and is marked U. □ S. U. S. Lake Survey B. M., 1901. Elevation, 200.3158 meters, 657.203 feet.

P. B. M. Caribou is 4½ miles west of Detour, Mich., top of an iron bolt leaded in the top of a cut stone, 6 inches by 6 inches by 20 inches, buried in sand, with its top end 2½ feet below the surface. A 6-inch cedar post, 4 inches by 4 inches at the top and marked "U. S. B. M." on opposite sides, is planted over the stone for a surface mark. The stone is 364 meters east of the point where the wagon road leaves the water's edge of Caribou Lake, 2½ meters north of the center of the wagon road, and 50 meters south of Caribou Lake. Old name of B. M. was "Caribou Lake." U. S. Lake Survey B. M., 1895. Elevation, 194.9021 meters, 639.441 feet.

T. B. M. 185 is 4½ miles west of Detour, Mich., top of a 20d wire nail driven in the top of a 30-inch hemlock stump, 3 inches from the north edge of stump, 4 meters south of center of wagon road, 2 meters southwest of telephone pole, 327 meters east of a point where the wagon road leaves the water's edge of Caribou Lake, about 50 meters south of Caribou Lake, and 37 meters west of P. B. M. Caribou. U. S. Lake Survey B. M., 1901. Elevation, 195.8292 meters, 642.483 feet.

P. B. M. Schlesser is 1 mile west and 1 mile north of Schlesser post-office, Mich., top of a ⅝-inch iron bolt leaded vertically in the top of a cut stone, 6 inches by 6 inches by 20 inches, and buried with its top 2½ feet below the surface of the ground. The bolt projects one-fourth inch above the surface of the stone between the letters "U. S." A stone, 6 inches by 8 inches by 14 inches, is planted in a vertical position over the mark and projects 2½ inches above the ground. The stone is at Rusks Corners, 1 mile north of Camerons Corners, in the center of the road leading west, near the west fence line of the north and south road, 57½ meters north-

east of the northeast corner of the schoolhouse, 190 meters east of the creek crossing the road, 17½ meters northwest of the fence corner, and 15½ meters southwest of another fence corner. The surface stone is marked on top thus:

U S
P B M

U. S. Lake Survey B. M., 1895. Elevation, 214.2514 meters, 702.923 feet.

T. B. M. 173 is at Gatesville, Mich., summit of a small square cut on the highest point of an embedded limestone bowlder which lies in a small ditch west of the wagon road running north from the Gatesville post-office. It is 5 meters east of north and south fence on west side of road, 133 meters north of intersection of roads at Gatesville post-office, and 1,435 meters south of P. B. M. Gatesville. U. S. Lake Survey B. M., 1901. Elevation, 225.0561 meters, 738.371 feet.

P. B. M. Raber is at Raber, Mich., top of a ¾-inch iron bolt leaded in top of a cut stone, 6 inches by 6 inches by 20 inches, buried 2½ feet below the surface of the ground. It is on the south line of the main street, 65 meters west of the water's edge of the St. Marys River, 76 meters east of intersection of narrow-gauge railroad and the main street, 75 meters from the entrance of a new church, 37 meters from the southwest corner of the Mud Lake Lumber Company's general store. A cedar post, 6 inches in diameter and 4 inches by 4 inches at the top, with the letters "U. S. B. M." cut on opposite sides, is planted over the mark and projects 2 feet above the ground for a surface mark. U. S. Lake Survey B. M., 1895. Elevation, 177.5291 meters, 582.444 feet.

P. B. M. Gatesville is 1 mile north of Gatesville, Mich., top of a ⅝-inch iron bolt set in the top of a cut stone, 6 inches by 6 inches by 20 inches, marked "U. S." on top and buried in the sand with its top 3 feet below the surface of the ground. A 6-inch cedar post, 4 inches by 4 inches on top, and marked "U. S. B. M." on opposite sides, is planted over the stone for a surface mark. The post projects 2½ feet above the ground on the north side of the county road 1 mile north of Gatesville post-office, and is 7 feet west of a large hemlock stump at the corner of the road. U. S. Lake Survey B. M., 1895. Elevation, 218.6928 meters, 717.495 feet.

P. B. M. Hudson, SE. cor. sec. 27, T. 43 N., R. 2 E., Chippewa county, Mich., top of a ¾-inch iron bolt leaded in the top of a cut stone, 6 inches by 6 inches by 20 inches, which is buried in a vertical position in sand with its top 2½ feet below the surface; the letters "U. S." are cut in the top of the stone. It is 13 meters northwest of a section-corner stake, 3 meters south of east and west fence which is the south line of Mr. Frank Huber's property. It is 150 meters east of a point in the road opposite Mr. Huber's house, 125 meters north of creek crossing the road in the bottom of a large ravine, and 1 mile north of county road. A cedar post, 6 inches in diameter with its upper end 4 inches by 4 inches square, is planted over the stone for a surface mark, and has the letters "U. S. B. M." cut on opposite sides. Post projects about 2 feet above ground. Old name of B. M. was "Hudson's Corner." U. S. Lake Survey B. M., 1895. Elevation, 207.3347 meters, 680.231 feet.

T. B. M. 164 is the summit of a small square cut on the highest point of an embedded granite bowlder, 12½ meters west of P. B. M. Hudson, 5½ meters south of fence on the north side of east and west road, 21 meters west and 4 meters north of a section-corner stake, 140 meters east of a point on the road opposite Frank Huber's house, and about 125 meters north of creek which crosses the road at bottom of large ravine. Bowlder projects about one-half foot above ground, marked U. □ S. U. S. Lake Survey B. M., 1901. Elevation, 208.3275 meters, 683.488 feet.

P. B. M. Tripp, NE. cor. sec. 21, T. 43 N., R. 2 E., Chippewa County, Mich., top of a ⅝-inch iron bolt in top of a cut stone, 6 inches by 6 inches by 20 inches, buried about 2½ feet deep. Bolt projects about one-half inch above stone between the letters "U. S." A cedar post, 6 inches in diameter and 4 inches by 4 inches at the top, with the letters "U. S. B. M." cut on opposite sides, is planted over the stone and projects about 1½ feet above ground. Stone is on east side of road at the turn by the bluff, and 12½ meters south of section corner. Witness trees have all burned down. U. S. Lake Survey B. M., 1895. Elevation, 207.5100 meters, 680.806 feet.

P. B. M. Fairview, SE. cor. sec. 1, T. 43 N., R. 1 E., Chippewa County, Mich., top of a ½-inch bolt leaded vertically in the top of a dressed stone, 6 inches by 6 inches by 24 inches, buried 2½ feet below the surface of the ground. A cedar post, 4 inches square at the top, is planted over the stone for a surface mark, and projects about 2½ feet above ground with the letters "U. S. B. M." on opposite sides. It is on the east fence line of the county road, 26 meters north of junction of roads at

section corner and 38 meters south of the southwest corner of Fairview schoolhouse. U. S. Lake Survey B. M., 1895. Elevation, 209.4733 meters, 687.247 feet.

P. B. M. Campbell is 1 mile east and one-fourth mile south of Sterlingville, Mich., top of a brass bolt leaded in the top of a very large bowlder embedded in a field belonging to Robert Campbell. The bowlder, marked "U. S." and projecting 4 feet above ground, is 40 meters east of the east fence line of the north and south road, 400 meters south of road intersection, and 400 meters north of Robert Campbell's house, which stands on a high bluff 2 miles south of the Big Munuscong River. U. S. Lake Survey B. M., 1901. Elevation, 191.3572 meters, 627.811 feet.

P. B. M. Munuscong is at Kelden P. O., Mich., top of a ½-inch iron bolt cemented in the top of a cut stone, 6 inches by 6 inches by 24 inches, which is buried with its top 3 feet below the ground and marked by a 4-inch by 4-inch cedar post which is planted over the mark. The post, projecting 1 foot above the ground and marked "U. S. B. M." on the sides, is 4 meters east of the east fence line of the north and south road, 91 meters north of the north end of the large barn on the east side of the road, 440 meters south of the center of the wagon bridge over the Little Munuscong River, 950 meters north of the Big Munuscong River, and 420 meters south of the Kelden post-office. U. S. Lake Survey B. M., 1895. Elevation, 183.3394 meters, 601.506 feet.

P. B. M. Barbeau is at Barbeau P. O., Mich., top of a ½-inch iron bolt leaded vertically in the top of a dressed stone, 6 inches by 6 inches by 24 inches, which is buried on end 3 feet under the surface of the ground. It is surmounted by a 4-inch by 4-inch cedar post which projects about 1 foot above ground and is marked "U. S. B. M." on the sides. It is 1 meter north of the south fence of an east and west road, 59 meters west of an 8-inch lone oak tree standing in the road, and 31 meters east of a point in the road opposite the east line of a small schoolhouse which stands north of the road. It is on top of a hill and in front of Mr. Alex. Scales' house, 330 meters east of Barbeau post-office, which stands at the southeast corner of junction of roads. U. S. Lake Survey B. M., 1895. Elevation, 201.4372 meters, 660.882 feet.

T. B. M. 133 is near the mouth of the Charlotte River, Mich., summit of a small square cut on the top of a large sandstone bowlder lying on the north side of the road which runs east and west just south of Charlotte River. Bowlder lies 3 meters north of center of road and in line with the west side of Mr. Dyer's house on the north side of the road, 9 meters west of west line of Mr. James Greg's house on the south side of the road, 55 meters west of the Greg schoolhouse, which is on the north side of road, and 500 meters west of the center of Hay Lake road. U. S. Lake Survey B. M., 1901. Elevation, 189.5650 meters, 621.931 feet.

P. B. M. Charlotte is near the mouth of Charlotte River, Mich., at Hay Lake road crossing, top of a ⅝-inch iron bolt projecting 2 inches above the top of a cut stone, 6 inches by 6 inches by 24 inches, which is marked by the letters "U. S." and buried with its top 3 feet below the surface. For a surface mark a 4-inch squared cedar post is planted over the stone, projecting 1 foot above the ground, and marked with the letters U. S. B. M. on its sides. It stands 3 feet east of the Hay Lake road and 140 feet south of Charlotte River, and is referenced as follows: A 4-inch by 4-inch stone projecting 5 inches above ground and marked "U. S." on top is S. 64° 00′ W., and 59 feet distant; B. M. 3½ is N. 00° 50′ W., and 126 feet distant; the northeast corner of the house on the east side of road is S. 01° 10′ E.; the southeast corner of the house west of the road is S. 20° 40′ W. Old name of B. M. was "Charlotte River." U. S. Lake Survey B. M., 1895. Elevation, 183.5482 meters, 602.191 feet.

P. B. M. 3½ is near the mouth of Charlotte River, Mich., summit of a boat spike driven in the east root of a double elm tree, which stands 5 meters south of the bank of Charlotte River and just below wagon bridge over same. (The wood has rotted around spike but it appeared to be solid when connected with in August, 1901.) U. S. Lake Survey B. M., 1883. Elevation, 183.1702 meters, 600.951 feet.

T. B. M. 132 is near the mouth of the Charlotte River, Mich., top of a 30d wire nail driven in the west root of a 3-foot double elm tree which stands 5 meters south of the bank of the Charlotte River and just below the wagon bridge over the river on the Hay Lake road. Mark is on the opposite side of the tree from B. M. 3½. U. S. Lake Survey B. M., 1901. Elevation, 182.9851 meters, 600.344 feet.

P. B. M. Hinds is 3 miles north of Charlotte River at junction of Hay Lake and Rosedale roads, Mich., top of a brass bolt leaded vertically in a sandstone bowlder, 2 by 1½ feet by one-half foot, buried with its flat top 2½ feet below the surface of the ground. The surface mark is a small bowlder placed over the mark, projecting 4 inches above the surface and is 2 feet east and 1 foot south of the fence corner which is the southwest corner of the property of Mrs. John Hinds. The

property on the south of Rosedale road and east of Hay Lake road belongs to Van Lenven, and is 10½ miles south of the "Soo" locks, three-fourths mile west of St. Marys River, and 3 miles due north of Charlotte River. U. S. Lake Survey B. M., 1901. Elevation, 180.5007 meters, 592.193 feet.

P. B. M. Newcomb is near the St. Marys River, 7 miles below the "Soo" locks on the Hay Lake road, Mich. Top of an iron bolt cemented in the top of a bowlder buried with its surface 15 inches below the ground in the south end of an ash grove on the right bank of the St. Marys River, belonging to Mrs. Newcomb. A squared 5-inch pine post projecting 6 inches above the ground is planted over the bolt for a surface mark, and is 10 meters from top of bank, 5 meters south of the south fence line of lane leading from house to the river, and 3 meters south of the line of the north side of the large barn. U. S. Lake Survey B. M., 1883. Elevation, 178.2442 meters, 584.790 feet.

T. B. M. 124 is at Six Mile Point, St. Marys River, Mich., top of a 30d wire nail driven in the east root of a very large pine stump, which is 3 meters east of north and south fence on west side of Hay Lake road. It is 13 meters south of south line of Knox road and about one-fourth mile west of St. Marys River. U. S. Lake Survey B. M., 1901. Elevation, 185.9305 meters, 610.007 feet.

P. B. M. Riverside is at Riverside Cemetery, 4½ miles below the "Soo" locks, Mich. Center of a brass bolt leaded horizontally in the center of the sixth masonry course above ground at the south end of the gateway to the cemetery. The bolt, about 4 feet above ground, faces the St. Marys River and the stone is marked thus:

U S
P B M

U. S. Lake Survey B. M., 1901. Elevation, 179.8686 meters, 590.119 feet.

T. B. M. 123 is near Riverside Cemetery, St. Marys River, Mich., top of a 30d wire nail driven in the south root of a 2½-foot elm tree standing 8 meters inside of fence on river side of Hay Lake road and in line with east fence of road running south from this point, 1,143 meters below Riverside Cemetery entrance. Mark is 2 feet from body of the tree. U. S. Lake Survey B. M., 1901. Elevation, 179.6990 meters, 589.562 feet.

T. B. M. 121 is 4 miles below Sault Ste. Marie, Mich., top of a 30d wire nail driven in the southwest root of a 10-inch spruce tree standing 8 meters north of the center of the Hay Lake road, 597 meters below junction of road leading to Chippewa County poorhouse. Mark is 1½ feet from body of tree. U. S. Lake Survey B. M., 1901. Elevation, 179.9937 meters, 590.529 feet.

P. B. M. Little is 2½ miles below "Soo" locks. Gauge B. M. on upper island. Top of a square iron bolt cemented in the top of a sandstone bowlder set flush with the surface of the ground, on upper island of Little Rapids, 10 meters back of Government light on right shore of main channel of St. Marys River. Old name of B. M. was "Little Rapids." U. S. Lake Survey B. M., 1883. Elevation, 178.6936 meters, 586.264 feet.

P. B. M. No. 14 is 2½ miles below the "Soo" locks at Sault Ste. Marie, Mich., top of a 1-inch square iron bolt fox wedged and cemented in the top of a bowlder 2 feet by 1½ feet and projecting about 1 foot above the ground. It is 8 meters east of center of wagon road along the St. Marys River, 17 meters south of path leading toward the river and to rustic bridge crossing slough to small island, 51 meters west of west bank of slough, 165 meters above boathouse of Country Club, and 267 meters below △ East Base ("Soo" Base Line). U. S. Lake Survey B. M., 1883. Elevation, 178.7058 meters, 586.304 feet.

T. B. M. 119 is 2 miles below "Soo" locks, top of a 30d wire nail driven in the south root of a 3-foot elm tree which stands 2 meters inside of fence on the river side of the river road below Sault Ste. Marie, Mich.; 180 meters above the intersection of roads, 340 meters above small bridge over small creek which crosses the road, and 554 meters above △ East Base ("Soo" Base Line). U. S. Lake Survey B. M., 1901. Elevation, 179.2866 meters, 588.209 feet.

P. B. M. Soo is at Sault Ste. Marie, Mich., center of a brass bolt leaded horizontally in the north side of a red sandstone, the third above ground at the northeast corner of the Chippewa County court-house, and is 2½ feet above the ground and 6 inches west of the northeast corner of building. U. S. Lake Survey B. M., 1901. Elevation, 188.9070 meters, 619.772 feet.

T. B. M. 117 is at Sault Ste. Marie, Mich., summit of a small square 1 inch by 1 inch cut on top of the first stone above ground at the northeast corner of the Chippewa County court-house. It is 6 inches above the ground, 5 inches west of the northeast corner of the building, and 2.15 feet directly below P. B. M. "Soo," U. S. Lake Survey B. M., 1901. Elevation 188.2528 meters, 617,626 feet.

P. B. M. "A" is at Sault Ste. Marie, Mich., summit of a square 2 inches by 2 inches cut on top of masonry on the north side of the Weitzel lock. It is 10 inches south of the north edge of masonry and is directly in line of lower gate at the upper end of the Weitzel lock, and about 150 meters west of the Government building. U. S. Lake Survey B. M., 1881. Elevation, 184.7301 meters, 606.069 feet.

P. B. M. "B" is at Sault Ste. Marie, Mich., summit of a square 1½ by 1½ inches cut on top of masonry at the foot and on the north side of Poe lock. It is 5 inches south of the south side of steps leading down on the north side of Poe lock and is directly in line with the front egde of the second step from bottom. U. S. Lake Survey B. M., 1901. Elevation, 179.4145 meters, 588.629 feet.

T. B. M. 90 is at Sault Ste. Marie, Mich., the summit of a small square 1 inch by 1 inch cut on top of masonry on the south side of Sault Ste. Marie Canal at the movable dam. Mark is on the southwest corner of masonry, 6 inches from the south side and 8 inches from the west side. It is 115 meters east of railroad and 900 meters west of the west end of Weitzel lock. U. S. Lake Survey B. M., 1901. Elevation, 185.0313 meters, 607.057 feet.

P. B. M. Meridian is at Sault Ste. Marie, Mich., summit of the square head of an iron bolt leaded in the top of a stone monument marking the intersection of the principal meridian and the south line of the Sault Ste. Marie grant. It is in line of center of Meridian street (Meridian street bounds Fort Brady on the west) and is 4 feet east and 12 feet north of southeast corner of stone abutment of plate-girder bridge, carrying Soo Railroad over wagon road. Mark is 2 feet below the surface of the ground, and the hole is walled up and covered with large stones. U. S. Lake Survey B. M. Elevation, 185.2683 meters, 607.834 feet.

T. B. M. 94 is 2½ miles above Sault Ste. Marie, Mich., summit of a small square 1 inch by 1 inch cut on top of a very large bowlder about 6 feet by 10 feet which lies 5 meters north of the Minn., St. Paul and Sault Ste. Marie Ry. and 21 meters south of the Duluth, South Shore and Atlantic Ry., 1,800 meters west of a prominent point of bluff near the North Western Leather Co.'s buildings on the north side of the railroads, 250 meters east of a prominent point of bluff on the south side of the tracks, at which point the two railroads separate, marked U. □ S. U. S. Lake Survey B. M., 1901. Elevation, 195.1080 meters, 640.117 feet.

P. B. M. Neaseville is at Sault Ste. Marie, Mich., top of a brass bolt leaded vertically in the top of a large sandstone bowlder, which lies well embedded in a small ditch in small cut of the Soo Railroad. The bolt is 1.95 meters south of south rail of track, 35 meters west of road crossing, 63 meters east of point of curve of track, and 185 meters east of smokestack of Northwestern Leather Company's tannery. Marked in 3-inch letters "U. S." U. S. Lake Survey B. M., 1901. Elevation, 195.5952 meters, 641.715 feet.

T. B. M. 115 is at Brush Point, Mich., top of a 10d wire nail driven in the south root of a 15-inch white pine tree, which stands in the upper end of a clearing known on chart No. 3 as Solomon's; tree is 3½ meters below old fence which runs back from St. Marys River, 16 meters south of top of bank of river, 3½ meters east of P. B. M. Solomon, and 925 meters below Brush Point by shore line of river. U. S. Lake Survey B. M., 1901. Elevation, 186.4794 meters, 611.808 feet.

P. B. M. Solomon is at Brush Point, St. Marys River, top of a brass bolt leaded vertically in the top of a sandstone, 15 inches by 12 inches by 6 inches, buried in Solomon's clearing, 3 feet below the surface of the ground, 3½ meters west of a 15-inch white pine tree on which is blazed a 9-inch triangle. The surface mark, a stone 15 inches by 6 inches by 6 inches, marked "U. S." on top and projecting 6 inches above ground, is placed over the bolt and is 16 meters south of the top of the river bank on the line of an old fence running back from the river; 925 meters, by shore line, below Brush Point. U. S. Lake Survey B. M., 1901. Elevation, 185.4218 meters, 608.338 feet.

P. B. M. Brush is at Brush Point, Mich., top of center of one of five wire spikes driven in the top of a very large hub on top of low bank, and is 5 meters back of staff gauge and 35 meters west of the northwest corner of a large boathouse on the south shore of St. Marys River. U. S. Lake Survey B. M., 1892. Old name of B. M. was Brush Point. Elevation, 184.0144 meters, 603.721 feet.

P. B. M. No. 1 is on the Duluth, South Shore and Atlantic Ry., 200 meters north of the 3-mile post. Top of a copper bolt set in the summit of a large bowlder 12 feet west of the center line of the track and marked on the east face with the letters "U. S. B. M." U. S. Lake Survey B. M., 1892. Elevation, 195.7102 meters, 642.092 feet.

P. B. M. No. 2 is on the Duluth, South Shore and Atlantic Ry., 29 feet north of the 6-mile post. Top of a copper bolt leaded vertically in the summit of a bowlder buried to a depth of 4 feet, 41 feet west of the center of the track. A red sand-

stone projecting 1 foot above the ground and marked "U. S. B. M." on top is set directly over the bolt for a surface mark. U. S. Lake Survey B. M., 1892. Elevation, 195.4862 meters, 641.358 feet.

P. B. M. No. 3 is on the Duluth, South Shore and Atlantic Ry., 21½ feet north of the 9-mile post, top of a copper bolt leaded vertically in the summit of a stone monument buried 31 feet west of the center of the track to a depth of 4 feet. A 6-inch square cedar post, projecting 16 inches above the ground, is planted over the bolt for a surface mark. U. S. Lake Survey B. M., 1892. Elevation, 204.3235 meters, 670.351 feet.

P. B. M. No. 4 is at Brimley, Mich., on the Duluth, South Shore and Atlantic Ry., 200 feet east of the station, top of a copper bolt leaded vertically in the top of a stone monument 18 inches square, 4 feet below the surface of the ground, 34½ feet north of the center of the track, 192 feet west of the west end of the Waiska River railroad bridge, and due north of the frog for the branch railroad across Waiska Bay. An old cedar post carved with the letters "U. S. B. M." stands 1 foot west of the bolt, and a red sandstone, 20 inches by 8 inches by 6 inches, projecting 8 inches above the ground and marked

U. S. B. M.
No. 4.

lies directly over the bolt. U. S. Lake Survey B. M., 1892. Elevation, 197.5225 meters, 648.038 feet.

P. B. M. Bay Mills is at Bay Mills, Mich., top of a brass bolt leaded vertically 8 inches from the west and 7 inches from the north side of the pedestal (marked "U. S.") on the southeast foundation for the steel water-tank tower which stands on the south side of Hall and Munson's factory power house. U. S. Lake Survey B. M., 1901. Elevation, 185.7995 meters, 609.577 feet.

T. B. M. 109 is at Mission, Mich., top of a 60d wire nail driven in the north root of a 12-inch spruce tree, which stands alone, 21 meters southwest of the top of high bank of St. Marys River, 25 meters east of a log house owned by Duel Cameron. Tree is on top of bank on north side of large ravine, 5 meters south of wagon road from Indian Mission to Iroquois light-house, and 16 meters southwest of P. B. M. Mission. Tree is blazed with a 4-inch triangle, 4 feet above B. M. U. S. Lake Survey B. M., 1901. Elevation, 194.1068 meters, 636.832 feet.

P. B. M. Mission is 2½ miles above Bay Mills, Mich., top of a brass bolt leaded vertically in the top of a sandstone 14 inches by 10 inches by 6 inches, and buried about 3 feet under the ground at the top of a point of a sand terrace in the upper end of the mission, and on the west side of a broad ravine running back from the St. Marys River. It is about 4 meters back from crest of high bank of river, 16 meters northeast of a spruce tree blazed with a 4-inch triangle (T. B. M. No. 109 on root of tree), 42 meters east of a log house owned by Duel Cameron, 142 meters above a small bridge over small creek crossing the road in bottom of ravine, and 1 mile above store at lower end of mission. A sandstone 8 inches by 10 inches by 15 inches is set directly over the P. B. M. for a surface mark and projects about 5 inches above ground marked

U S
P B M

U. S. Lake Survey B. M., 1901. Elevation, 194.0624 meters, 636.686 feet.

P. B. M. △ is at Iroquois Point, Mich., top of a brass bolt leaded vertically in top of a stone monument 6 inches square, set in the ground at the east side of the light-house yard, 2 feet west of the north and south fence, 37½ feet east of the northeast corner of light-house building, and about on line with north side of building. Marked "U. S." U. S. Lake Survey B. M., 1901. Elevation, 188.4956 meters, 618.423 feet.

P. B. M. Iroquois is at Iroquois Point, Mich., top of an iron bolt 1 inch square cemented in the top of a bowlder 4 meters east of walk from light-house to engine house, 29 meters south of east entrance of engine house, 60 meters south of shore of St. Marys River, and 30 meters north of high bank. U. S. Lake Survey B. M. Elevation, 185.3358 meters, 608.056 feet.

P. B. M. Iroquois No. 1 is at Iroquois Point, Mich., top of a brass bolt leaded vertically in the top of a stone 8 inches by 8 inches by 20 inches buried 2½ feet under ground in the southeast corner of the light-house yard. It is 1 foot from the south fence and 2 feet from the east fence. A stone 8 inches by 8 inches by 18 inches is set in ground directly over the P. B. M. for a surface mark and pro-

jects about 6 inches above ground. It is 11½ meters east and 18 meters south of extreme southeast corner of the light-house building. Marked

U S
P B M

U. S. Lake Survey B. M., 1901. Elevation, 187.4807 meters, 615.093 feet.

P. B. M. Iroquois Light-house is at Iroquois Point, Mich., center of a brass bolt leaded horizontally in the center of a large stone on north side of Iroquois light-house. Stone is in the top course of masonry of foundation of the light-house, which is built of brick and was erected in 1870. It is 5 feet east of old B. M. and marked

U S
P B M

U. S. Lake Survey B. M., 1901. Elevation, 189.5959 meters, 622.033 feet.

P. B. M. Old B. M. is at Iroquois Point, Mich., a square notch cut in top of foundation of the light-house on north side and 5 feet west of P. B. M. Iroquois light-house. Marked □ B. M. U. S. Lake Survey B. M. Elevation, 189.8013 meters, 622.707 feet.

DESCRIPTIONS OF BENCH MARKS FROM ESCANABA, MICH., TO MARQUETTE, MICH., CONNECTED WITH OR ESTABLISHED BY PRECISE LEVELS OF UNITED STATES LAKE SURVEY IN 1876.

B. M. No. 1 (1874), Escanaba, Mich., is the top of the water table of the large brick building of S. Adler, on the northwest corner of Ludington street and Dauseman avenue, on the southeast corner of the building. Elevation, 180.9320 meters, 593.608 feet.

B. M. No. 3 (1876), Escanaba, Mich., is the center of small hole in copper bolt leaded into masonry foundation on the west side of Escanaba light-house, near northwest corner. Elevation, 178.9538 meters, 587.118 feet.

B. M. No. 4 (1876) is the center of small hole in copper bolt leaded into natural rock on east side of Chicago and Northwestern Railroad, about 36 meters north of switch of siding leading to charcoal kilns at Maple Ridge, Mich. Elevation, 292.3706 meters, 959.219 feet.

B. M. No. 5 (1876) is the center of small hole in copper bolt leaded into natural rock, about 74 meters east and 53 meters south of switch at north end of siding at Sands, Mich. Elevation, 366.5827 meters, 1,202.697 feet.

B. M. No. 6 (1876), Marquette, Mich., is the center of small hole in copper bolt leaded into third course of masonry above water table on north side of Marquette, Houghton and Ontonagon Railroad general freight and ticket office, about 1 foot from northeast corner. Elevation, 191.5409 meters, 628.414 feet.

B. M. No. 1 (1871), Marquette, Mich., southeast corner of the top of the foundation stone of Grace furnace. (Reported destroyed.) Elevation, 186.0774 meters, 610.489 feet.

B. M. No. 2 (1874), Marquette, Mich., cross on the window sill of the Marquette city waterworks. It is on the north window, west side of building, and north side of window. (Reported destroyed.) Elevation, 185.9250 meters, 609.989 feet.

B. M. No. 3 (1874), Marquette, Mich., is a cross on the window sill of the Marquette city waterworks. It is on the north window, east side of building, and 6 inches from north end of sill. (Reported destroyed.) Elevation, 185.9006 meters, 609.909 feet.

B. M. No. 11 (1896) is on the water table, 10 inches from southwest corner, on south side of new pump house of city waterworks, Marquette, Mich. Elevation, 189.1830 meters, 620.678 feet.

DESCRIPTIONS AND ELEVATIONS OF BENCH MARKS DIRECTLY CONNECTED BY WATER LEVELS WITH THE NEW PRIMARY LEVELS.

B. M. No. 1 (1873), Erie, Pa., the highest point of a stone post 336 feet distant from the nearest point of the pier on which the water gauge is situated, and on the north side. The northeast corner of the light-keeper's dwelling is 228 feet distant and bears S. 68° E. Elevation, 175.3795 meters, 575.391 feet.

B. M. U. S. Engineers, Erie, Pa., chisel mark on southwest corner of foundation of light-keeper's dwelling, Erie Harbor. Elevation, 176.0501 meters, 577.591 feet.

B. M. No. 1, Cleveland, Ohio. A mark (B × M) on the top of the northeast wall of the Ohio Canal lock, at the connection of the canal with the river. Elevation, 177.2131 meters, 581.407 feet.

B. M. No. 2, Cleveland, Ohio. A cross (×) on the water table, northeast corner of Johnson House Block, southwest corner of Front and East River streets. Elevation, 176.0945 meters, 577.737 feet.

B. M. No. 3, Cleveland, Ohio. A cross (×) on the stone water table, southwest corner of brick block, northeast corner of River and Superior streets. Elevation, 181.2730 meters, 594.727 feet.

Gauge B. M., Amherstburg, Ont., Canada. Top of a ship spike driven into the top of a maple stump 1 foot in diameter and about one-half foot above the ground. The stump is about 30 feet from the water's edge and about 100 feet north from a point abreast of the gauge house. Elevation, 176.5321 meters, 579.172 feet.

U. S. B. M., Sand Beach, Mich., is on a granite boulder about three-fourths of a mile from the custodian's office. The boulder is at the edge of the bluff and nearly in line with the north side of the west pier. The B. M. is in relief, about 3 inches square, three-eighths inch above the remainder of the stone, and bears the letters U. S. B. M. Elevation, 179.1662 meters, 587.814 feet.

U. S. B. M. *A.*, Sand Beach, Mich., is the top of a round iron rod 1 inch in diameter, slightly sharpened at the top, and resembling a drift bolt. The rod is fox wedged into the rock, and is at the west end of the U. S. boathouse in front of the U. S. engineer office. Elevation, 177.8693 meters, 583.560 feet.

U. S. B. M. *B.*, Sand Beach, Mich., is the top of a mill shaft, 1½ inches in diameter, with head turned on at the top; it is fox wedged into the rock just south of the U. S. boathouse and near the east end. Elevation, 177.7519 meters, 583.174 feet.

U. S. B. M. *E.*, Sand Beach, Mich., is the top of a bar driven into the rock under the dock, about one-fourth mile from the U. S. engineer office. It is about 250 feet from the outer end of dock. Elevation, 177.7620 meters, 583.207 feet.

U. S. B. M. Jenks, Sand Beach, Mich., is on the water table at the southwest corner of J. Jenks and Company's brick store. The B. M. is marked. Elevation, 186.0986 meters, 610.559 feet.

U. S. B. M. "Boulder in Harbor," Sand Beach, Mich., is the center of a square cut on a bowlder about 550 feet south of the U. S. engineer office. This B. M. was established in 1873–74 by Assistant Engineer Gilbert and is called B. M. "Boulder in Harbor." Elevation, 177.6004 meters, 582.677 feet.

B. M. No. 1. Mackinaw City, Mich., is a level summit 1 inch by 1 inch on a shelf 1 inch by 2 inches, cut in the rough stone face of the first course of masonry on the north side of "Old Point Mackinaw" light-house. It is 1½ feet above the ground and 2 feet west of the center of a slot window facing the water. The letter "B" is cut above the east end of the shelf. Elevation, 180.1119 meters, 590.917 feet.

B. M. No. 2, Mackinaw City, Mich., is the top of edge of stone forming doorsill of the door in the light-keeper's house that is nearest the light-house tower, the B. M. being at the easterly side of the door, on the level part of the stone, next to the bevel of the sill and at the middle of the 8-foot stone, the west half of which forms the doorsill. Elevation, 180.7940 meters, 593.155 feet.

B. M. No. 3, Mackinaw City, Mich., is the top of a ½-inch brass tube set vertically in a block of concrete 1 foot in diameter and 2.7 feet long, set 1.8 feet below the surface of the ground just north of the railway crossing on Huron avenue. It is 13.3 feet north of north rail of most northerly track of M. C. R. R.; 6.9 feet south of south rail of G. R. & I. R. R.; 6.4 feet east of lamp-post between above-named tracks; 2.6 feet west of west edge of plank sidewalk on west side of Huron avenue. Top of concrete is marked

U S
19 o 01
B M

Elevation, 178.9012 meters, 586.945 feet.

B. M. R., Mackinaw City, Mich., is the top of a railroad rail set vertically in the ground on the west side of Huron avenue near the west street line. It is 44.8 feet north of B. M. No. 3; 184.1 feet west of northwest corner of pump house, measurement made in line with north face of pump house, which is on the east side of Huron avenue. The rail projects about 1 foot above ground. Elevation, 179.8144 meters, 589.941 feet.

B. M. No. 4, Mackinaw City, Mich., is the top of a ½-inch brass tube set vertically in a concrete block 1.4 feet long set 2.3 feet below the ground. It is 64.7 feet east of B. M. R., 85.4 feet northeast of B. M. No. 3, 119.4 feet west of northwest corner of pump house, on east side of Huron avenue, measured in line with north face of pump house. Top of the concrete is marked

U S
19 ○ 01
B M

Elevation, 178.0464 meters, 584.141 feet.

B. M. No. 1, Milwaukee, Wis. This B. M. was formerly on house of Dr. I. A. Lapham, but has been destroyed by repairs to the house. Elevation, 180.7545 meters, 593.025 feet.

B. M. No. 2, Milwaukee, Wis. Stone monument in court-house square, near the southeast corner therof, in the Seventh Ward. Elevation, 193.8701 meters, 636.055 feet.

B. M. No. 3, Milwaukee, Wis. Stone monument on sidewalk at southeast corner of Eighth and Chestnut streets, Second Ward. Elevation, 193.2330 meters, 633.965 feet.

B. M. No. 4, Milwaukee, Wis. The highest point of the stone water table at the corner of the building, Ludington's Block, northwest corner of East Water and Wisconsin streets. Elevation, 181.1446 meters, 594.305 feet. Destroyed.

B. M. No. 5 (1876), Milwaukee, Wis., a cross on the masonry of the Kilbourne grist mill at the foot of Poplar street. It is cut in the stone 10½ inches from the southeast corner on the east wall, and about 3 feet above the surface of the ground. Elevation, 179.9986 meters, 590.545 feet. Destroyed.

P. B. M. No. 99, Chicago, Ill., is the center mark of a copper bolt leaded horizontally in the east face of the foundation wall of the Illinois Central R. R. stone freight depot, situated on Goodrich street docks on the west side of slip A, opposite the Central elevator. Bolt is 1 foot south of the northeast corner and 2½ feet above the ground. Elevation, 180.3077 meters, 591.560 feet.

B. M. No. 1, Duluth, Minn., is the upper surface of the water table of Miller's Block, at the east corner of Lake avenue and Superior street. It is 12 feet 1 inch south of the corner of building, and on the Lake avenue side. Established in 1873. Elevation, 191.1611 meters, 627.168 feet.

B. M. No. 23, Duluth, Minn., is the top surface of a granite pedestal supporting an iron post of the Sixth avenue viaduct over the railroad tracks. It is marked by a square of black paint, 2 inches in diameter, and is at the eastern end of the southern bent of posts and is near the north line of Railroad street. Elevation, 185.8113 meters, 609.616 feet.

B. M. No. 1, Charlotte, N. Y., on the upper side of the water table of the lighthouse at the south-southeast angle, east of the south window. Elevation, 86.3097 meters, 283.168 feet.

B. M. No. 2 (1874), Charlotte, N. Y., a bench-mark (B × M) on the top of the circular wall of the railroad turn-table, southwest part of the wall. Elevation, 77.2297 meters, 253.378 feet.

B. M. 1 (1874) is at Sacketts Harbor, N. Y., being a cross on the solid rock between the sidewalk and the water, N. 2° E. from the northwest corner of the Masonic Temple, and 96½ feet distant. Elevation, 76.7976 meters, 251.96 feet.

B. M. 2 is at Sacketts Harbor, N. Y., being the upper side at the outer edge of the water table at the northeast corner of the stone Masonic Temple. Elevation, 80.6563 meters, 264.62 feet.

B. M. 3 (check point) (1875) is at Sacketts Harbor, N. Y., being the intersection of two perpendicular lines in the head of a 7-inch screw bolt leaded into the natural rock, situated about three-eighths of a mile down the bay from the United States naval quarters. Elevation, 76.2885 meters, 250.29 feet.

B. M. "A" is at Port Dalhousie, Ont., being the top of stone post buried under sidewalk, corner of Canal and Lock streets, 10½ feet from southeast corner of "Wood House" on perpendicular to east side of "Wood House" toward canal, about 110 feet west of heel post of west gate of north end of canal lock. Elevation, 80.4582 meters, 263.97 feet.

B. M. "B" is at Port Dalhousie, Ont., being edge of cut in top course of masonry in north recess in east wall of canal, 20 feet north of northeast gate of lock. Elevation, 78.6355 meters, 257.99 feet.

B. M. "C" is at Port Dalhousie, Ont., being cross cut into stone of foundation of customs collector's office, third course of stones from top, north side, 1.4 feet from northwest corner. Elevation, 78.6904 meters, 258.17 feet.

B. M. on custom-house (1875) is at Port Colborne, Ont., being top of point of iron bolt set in masonry of stone foundation of custom-house, west side, southwest corner. Elevation, 178.1803 meters, 584.58 feet.

B. M. on Baptist Church (1875) is at Port Colborne, Ont., being top of point of iron bolt in east end of window sill in basement of steeple, south side of Baptist Church. Elevation, 176.9002 meters, 580.38 feet.

B. M. on Church of England (1875) is at Port Colborne, Ont., being top of point of iron bolt in stone foundation, lower tier of stones in south side of Church of England (street front, east side of entrance). Elevation, 176.4582 meters, 578.93 feet.

B. M. (1873) is at Port Austin, Mich., being the head of a 6-inch bolt leaded into the rock 13 feet southwest of the gauge. The letters B. M. are cut in the rock near it. Elevation, 180.1280 meters, 590.97 feet.

DESCRIPTIONS OF PERMANENT BENCH MARKS BETWEEN GIBRALTAR, MICH., AND TOLEDO, OHIO.

P. B. M. Gibraltar, 1877, is at Gibraltar, Mich., in foundation wall of light-house tower—now (1899) abandoned and used as a dwelling—at its southeast corner, east face, in fourth course of masonry below the cut sandstone water table, being center of small hole in head of copper bolt leaded horizontally. Elevation, 177.5549 meters, 582.528 feet.

P. B. M. 2 of 1875, is in Gibraltar, Mich., on the same light-house as above—now (in 1899) used as a dwelling—on the southeast corner of the stone doorsill of the door in the southeast angle of the building, being marked by a right angle cut on the stone. Elevation, 178.3220 meters, 585.041 feet.

U. S. P. B. M. 1 is in Gibraltar, Mich., in south part of the town, on lake front, in the rear of Mr. Edward Hall's dock and boathouse, 75 feet southwest of his house, in the northeast corner of stone milk house, in east face, 8 inches south from corner and 4 feet 4 inches above ground, being center mark of brass bolt leaded horizontally. Elevation, 179.1037 meters, 587.610 feet.

P. B. M. A. is in South Rockwood, Mich., 17 feet west of center of Michigan Central track, 198 feet south of depot, on the southeast stone pillar of water tank on the northeast corner of stone, being bottom of a square cut 1 inch on a side and one-half inch deep. Elevation, 179.0201 meters, 587.335 feet.

P. B. M. B. is in Newport, Mich., on line of Michigan Central track, about 360 feet above the depot, in south abutment of bridge over Swan Creek, in end of north face, 3 feet above ground, being center of horizontal mark in brass bolt leaded horizontally. Elevation, 176.9056 meters, 580.398 feet.

P. B. M. C. is in Monroe, Mich., on the west end of south pier of Michigan Central Railroad bridge over the Raisin River on the west face of pier, 6 inches north of its south edge and about 4 feet above ground, being horizontal mark in brass bolt leaded horizontially. Elevation, 177.1087 meters,[a] 581.064 feet.

P. B. M. D. is in Monroe, Mich., on the south side of First street, 345 feet west of Kentucky avenue, on northwest corner of city fire-engine house, on northeast corner of pedestal stone just under brickwork, being bottom surface of a square cut 1 inch on side and ½ inch deep. Elevation, 180.0669 meters, 590.769 feet.

P. B. M. E. is 1½ miles below La Salle station, Mich., on line of the Lake Shore and Michigan Southern Railroad, 115 meters below Lagerness road crossing, 3.38 meters east of east rail of track, on south side of open stone culvert, on top stone, 3½ feet above ground, and is a square cut. Elevation, 177.4923 meters, 582.323 feet.

P. B. M. F. is at Vienna station, on Michigan Central and Lake Shore and Michigan Southern railroads, Erie Township, Monroe County, Mich., 325 feet west of track on north side of road to Erie (on the section line E. W. of section 16), about 20 rods west of center of section, on southwest corner of Mrs. William McLain's house, in the east end of water-table stone of the south side of the building, about 2½ feet above ground, being a brass bolt. Elevation, 179.4748 meters, 588.827 feet.

P. B. M. U. is in Lucas County, Ohio, at a place called Alexis (on time-table), being at the intersection of the Lake Shore and Michigan Southern and Ann Arbor, Detroit and Toledo roads, on the west side of the Lake Shore and Michigan Southern, and on the northeast side of the Ann Arbor road, on west abutment south side of long culvert of very large stone, on the first step, below coping at its northwest corner, 5 inches from either face, and is a square cut. Elevation, 178.4551 meters, 585.481 feet.

P. B. M. Toledo City, No. 165, is in northern part of Toledo, near the Maumee River, on west side of Summit avenue and north corner of Columbus avenue, on frame building, being a copper nail on east side of sign. Elevation, 181.7888 meters, 596.419 feet.

P. B. M. Park △ is in Toledo, Ohio, on the north bank of the Maumee River, 106 meters above River Place, 1.35 meters south of south edge of flagging in River Park, being a stone triangulation monument set in the ground. The point taken is the east point of the triangle cut in stone. Elevation, 183.2213 meters, 601.118 feet.

P. B. M. V. is in Toledo, Ohio, on the north bank of the Maumee River, on the north abutment of the Pennsylvania Railroad bridge, east side, on retaining wall, 15 inches west of the northwest corner of the bridge seat block and 3 feet above it, and is a square cut. Elevation, 179.5632 meters, 589.117 feet.

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[a] Reported destroyed. New P. B. M. M. C. bridge, near Monroe, adjusted elevation, 178.0717 meters, 584.224 feet.

P. B. M. Power House, on the northeast corner of Water and Madison streets, Toledo, Ohio, on southwest corner of traction company's power house, on top of sandstone water table just where brick begins, about 3 feet above sidewalk, being marked by a square. Elevation, 177.6084 meters, 582.703 feet.

P. B. M. W. is in Toledo, Ohio, on the United States custom office building, on the southeast corner of Madison and St. Clair streets, 15 feet south of the south side of entrance on St. Clair street, on the south face of pilaster angle, 6 inches east of west face and $1\frac{1}{2}$ meters above ground, being a brass bolt. Elevation, 184.0653 meters, 603.888 feet.

P. B. M. Post-Office is on the northwest corner of custom-house building in Toledo, Ohio. A cross, cut on the top of the granite water table just where sandstone begins, being the outer quarter of cross. Elevation, 183.6608 meters, 602.560 feet.

P. B. M. Toledo City, No. 44, is on southwest corner of Madison and Summit streets, Toledo, Ohio. A cross, cut on northeast corner of water table of Robert's drug store. Elevation, 181.7741 meters, 596.370 feet.

P. B. M. Toledo City, No. 296, is in Toledo, Ohio, on the easterly abutment of the Pennsylvania Railroad bridge over the Maumee River, north side of track, on coping stone, 9 inches north of north side of guard timber of track, being highest point at northerly part of a cross. Elevation, 179.9396 meters, 590.352 feet.

BENCH-MARKS BETWEEN TRENTON, MICH., AND AMHERSTBURG, CANADA.

P. B. M. No. 2 is in Trenton, Mich., on the northwest corner of St. Joseph street and Washington avenue, in stone base of stone building belonging to Jos. Anderson, 5 feet 4 inches north of north side of door, $4\frac{3}{4}$ inches south of north pillar and 4 inches back from face, being top of brass bolt leaded vertically and marked U. S. P. B. M. Elevation, 183.3995 meters, 601.703 feet.

P. B. M. Trenton, 1877, is in Trenton, Mich., on the southeast corner of Washington avenue and St. Joseph street, in the northwest corner of Commercial Hotel, in west face, second stone from corner, and in first course below water table, being center of small hole in copper bolt, leaded horizontally. Elevation, 183.9443 meters, 603.495 feet.

P. B. M. Bridge is about 1 mile below Trenton, Mich., being a square cut on coping stone on northwest corner of east pier inside of truss of Michigan Central Railroad bridge crossing the Detroit River to Grosse Isle, Mich., and Stony Island, Mich. Marked

U S
□
B M

Elevation, 178.1729 meters, 584.556 feet.

P. B. M. Grosse Isle is on Grosse Isle, Mich., being a square cut on coping stone on north end of west course of west pier of Michigan Central Railroad bridge, connecting Grosse Isle, Mich., with Stony Island, Mich. Marked

U S
□
B M

Elevation, 178.1745 meters, 584.561 feet.

P. B. M. Monument is on the east side of Stony Island, Mich., on the top of an iron bolt leaded vertically in a stone monument about 3 feet above ground, located about 75 meters north of M. C. R. R. track and about 15 meters from water's edge. Elevation, 176.0297 meters, 577.524 feet.

P. B. M. Stone House is $1\frac{7}{8}$ miles above Amherstburg, Canada, being a mark on the water table on southwest corner of old stone house located about 120 meters back from road and about 500 meters below M. C. R. R. slip on Canadian shore. Elevation, 184.3371 meters, 604.779 feet.

P. B. M. Amherstburg, 1903, is a square cut on the north guard stone of the west steps of the city hall in Amherstburg, Canada. Marked

U S
□
B M

Elevation, 181.3426 meters, 594.955 feet.

P. B. M. Amherstburg, No. 1, is $\frac{5}{8}$ mile below city hall, Amherstburg, Canada, being the center of a brass bolt leaded horizontally about $2\frac{1}{2}$ feet above ground and about $1\frac{1}{2}$ feet south of northwest corner of house owned by A. E. Rondot, on the river road. Elevation, 179.1927 meters, 587.901 feet.

Gauge B. M. is about 1 mile below the city hall, Amherstburg, Canada, being the

top of an iron nail in top of stump about 6 inches above ground, located about 100 meters from U. S. L. S. automatic gauge house and about midway between road and river. Elevation, 176.5824 meters, 579.337 feet.

Bench Marks Between Monroe, Mich., and Monroe Light-House.

P. B. M. "D" is in Monroe, Mich., on the south side of First street, 345 feet west of Kentucky avenue, on northwest corner of city fire-engine house, on the northeast corner of pedestal stone, just under brickwork, being bottom surface of a square 1 inch on side and one-half inch deep. Elevation 180.0669 meters, 590,769 feet.

New P. B. M. M. C. R. R. bridge is in Monroe, Mich., being a brass bolt leaded vertically about 12 inches south of the bed plate of west truss, and in the top of and at the southwest end of the south pier of the M. C. R. R. bridge over the Raisin River. Marked

U S
●
B M

Elevation 178.0717 meters, 584.224 feet.

P. B. M. Monroe Piers is at Monroe Piers, Mich., being top of an iron bolt leaded vertically in a stone monument about 8 inches square near end of pier to light-house and about 5 meters north of Raisin River. Elevation 176.3740 meters, 578,654 feet.

P. B. M. Light-House is at Monroe Piers, Mich., being top of a brass bolt leaded vertically in cement foundation at southwest corner of light-house at the mouth of the Raisin River. Marked

U S
●
B M

Elevation 176.7496 meters, 579.886.

Two-foot mark above gauge-zero. Elevation 175.1634 meters, 574.682 feet.

Descriptions of Bench Marks from Algonac, Mich., to Lower Light-House at St. Clair Flats Canal.

P. B. M. 28 is in Algonac, Mich., in the foundation of the Town Hall, on its east face, sixth brick south from the northeast corner, and in the eighth course of above stone foundation; being center mark of brass bolt leaded horizontally. Elevation, 178.3538 meters, 585.149 feet.

P. B. M. Herson Island is on Herson Island, Mich., being nail in root on east side of large bass-wood tree in front of Porter J. White's cottage on east side of Herson Island. Nail is in center of 2-inch square cut on root, thus ⊡ Elevation 177.2161 meters, 581.416 feet.

P. B. M. Upper Light is at upper end of St. Clair Flats Canal, being top of a ⅝-inch brass bolt leaded vertically in northeast corner of second step of stone stairway on north side of Upper Light-House. Marked

U S
●
B M

Elevation 177.2646 meters, 581.576 feet.

P. B. M. Lower Light is at lower end of St. Clair Flats Canal, being center punch mark of a ⅝-inch brass bolt, leaded horizontally in center of stone over middle cellar window on east side of Lower Light-House. Marked

U S
●
B M

Elevation 177.1539 meters, 581.212 feet.

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[Report of 1902, pages 2883 to 3031; report of 1903, pages 2771 to 2776, and 2787 to 2809.]

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13	1902	2988
14 Ripley	1902	2988
15 Ripley	1902	2987
□ 15	1902	2989
17	1902	2987
21	1902	2988
Magnetic Station No. 1	1902	2989
Magnetic Station No. 2	1902	2989
St. Marys River, Lake George:		
□ A (1881)	1902	3000
□ B (1881)	1902	3000
Crib E (1879)	1902	2999
Crib E (1881)	1902	2999
Crib Light (foot of flats)	1902	2999
Crib Light (head of flats)	1902	2999
Crib W (1879)	1902	2999
Crib W (1881)	1902	2999
Crib W (1882)	1902	2999
□ 6	1902	2997
□ 8	1902	2997
C (1883)	1902	3000
□ 10	1902	2997
10 R	1902	2997
□ 12	1902	2997
12 R	1902	2998
□ 14	1902	2998
□ 16	1902	2998
□ 17	1902	2999
□ 18	1902	2998
18	1902	2995
□ 19	1902	2997
□ 20	1902	2998
20	1902	2995
□ 21	1902	2997
□ 22	1902	2998
22	1902	2995
□ 23	1902	2997
□ 24	1902	2999
24	1902	2995
□ 25	1902	2997
St. Marys River, Lake George—C't'd.		
□ 26	1902	3000
26	1902	2995
□ 27	1902	2998
27	1902	2995
□ 28	1902	3000
28	1902	2995
□ 29	1902	2998
29	1902	2995
30	1902	2995
□ 31	1902	2998
31	1902	2995
□ 31½	1902	2999
32	1902	2995
□ 32	1902	3000
□ 33	1902	2999
33	1902	2995
□ 34	1902	3000
34	1902	2996
34 R	1902	2997
□ 35	1902	2999
35	1902	2995
□ 36	1902	3000
36	1902	2998
□ 37	1902	2999
37	1902	2995
38	1902	2998
□ 39	1902	2999
39	1902	2995
40	1902	2996
□ 41	1902	3000
41	1902	2995
42	1902	2996
42½	1902	2998
□ 43	1902	3000
43	1902	2996
44	1902	2996
□ 45	1902	3000
45	1902	2996
46	1902	2996
46 R	1902	2999
□ 47	1902	3000
47	1902	2996
48	1902	2996
49	1902	2996
49 R	1902	2999
50	1902	2996
□ 51	1902	2997
51	1902	2996
52	1902	2997
53	1902	2996
54	1902	2996
□ 55	1902	2991
55	1902	2997
56	1902	2997
57	1902	2991
58	1902	2997
St. Marys River, Little Mud Lake:		
59	1902	2993
60	1902	2993
61	1902	2993
62	1902	2993
63	1902	2993
63½	1902	2994
64	1902	2994
65	1902	2994
66	1902	2994
68	1902	3001
70	1902	2994
72	1902	2994
74	1902	3001
91	1902	3001
93	1902	3001
95	1902	2994
97	1902	2994
98	1902	2994
104	1902	2994
St. Marys River, Middle Neebish:		
□ 51	1902	2991
□ 53	1902	2991
□ 55	1902	2991
55	1902	2991
57	1902	2991

Index of stations on United States standard datum—Tables of positions—Continued.

Index of stations on United States standard datum—Tables of positions—Continued.

Corrections to positions in report of 1902.

Page 2915, Hogsback: Seconds in meters 685.8 should be 68.6.
Page 2816, Rockland Island Light-house should be Rock Island Light-house.
Page 2919, Peak of Ogdensburg Light-house:
Seconds of latitude 52.44 should be 52.42; 1618.8 should be 1618.2.
Seconds of longitude 14.71 should be 13.77; 323.9 should be 303.4.

REPORT OF MR. FRANCIS C. SHENEHON, ASSISTANT ENGINEER.

STEAMER GENERAL WILLIAMS,
West End of Lake Erie, July 9, 1903.

MAJOR: I have the honor to submit a report on the work in my charge during the past year.

At the time of my last report the resurvey of the St. Lawrence River was in progress, with a triangulation party and one plane-table party in the field. The surveys of 1901 had carried the hydrography from St. Regis to the foot of the Galops Rapids, and topography had been taken from St. Regis to Johnstown. The surveys of the season of 1902 took up the hydrography at the head of the Galops Rapids and advanced it over a river length of 47 miles to the head of Wellesley Island, and advanced the topography over about the same length of river from Johnstown to Clayton, on the American side, and to the village of Selton, on the Canadian side.

The resurvey had for its object the modernization of the charts and the discovery of new shoals; but incidentally it perpetuated the secondary triangulation stations of the old survey of thirty years before.

The survey traversed the region of the Thousand Islands, whose development as a summer resort accounts for the very considerable changes in the artificial shore features since the original survey.

The formation that creates islands is fertile in shoals also, and the large number of new shoals discovered and developed is indicative of the nature of the bottom.

A discussion of the field methods used in the resurvey naturally divides itself into three parts: The triangulation, by which the details of land and water features are controlled; the topography furnishing the landmarks, by which the navigator may identify his position, and the hydrography or river survey proper.

The secondary triangulation of the original survey controlled the resurvey, and a difficult and tedious part of the work of the triangulation party was the relocation of these old stations.

It was necessary to put in some new stations where old ones had been destroyed, and it was also necessary to reduce the size of the triangles and gain additional stations for the reading in of plane-table signals by introducing several tertiary systems.

The following table shows the results of the search for old stations:

TABLE 1.—*Relocation of secondary triangulation stations.*

Stations found and perpetuated.	Stations not found.
1. Ogdensburg West Base.	1. Ogdensburg East Base.
2. I.	2. 37.
3. Brooks Point.	3. 2.
4. Maitland.	4. Ogdensburg Light-house.
5. K.	5. Railroad.
6. Morristown Point.	6. H.
7. Eaton.	7. G.
8. Taylor.	8. Brennan.
9. Moulson.	9. Maitland Northeast Base.
10. Halls Dock.	10. Maitland Southwest Base.
11. McDonald.	11. Finley.
12. Birch Point.	12. Campbell.
13. Mollys Gut.	13. Brockville Rock.
14. Oak Point.	14. XXI A. C. L.
15. Peach.	15. Chapman.
16. Slide.	16. Fulford.
17. Chippewa.	17. Lyons.
18. Whitney.	
19. Chimney.	
20. Dingman.	
21. Grenadier.	
22. Alexandria.	
23. Darling.	
24. Wells No. 2.	
25. Dorr Farm.	
26. Smoke.	

The stations found, 26 out of 43, represent 60 per cent of the whole; and if stations G, Brennan, Maitland Bases, and Finley, which are back from the river and redundant for the purposes of the resurvey, are thrown out of the count, the efficiency of the search is 26 out of 38, or better than 68 per cent.

The following stations of the old secondary were replaced by new tertiaries, near the old locations and the names retained, with the addition of "1902."

1. Ogdensburg East Base.
2. 2.
3. H.
4. Brockville Rock.
5. Chapman.
6. Fulford.
7. Lyons.

The following new tertiaries, distinct in position from the secondaries, were established:

8. Guernsey.
9. Cooks Point.
10. Cherry.
11. Third Brother.
12. Tuesday.
13. A.
14. B.
15. Poole.
16. Turkey.
17. Excelsior.
18. Bluff.
19. Waterloo.
20. St. Lawrence.
21. Park.
22. Fisher.
23. Garlock.
24. Crawford.
25. Hill.
26. Echo.
27. Rift.
28. Wind.
29. Rock.

The geographical positions of these tertiaries are given in tabulated form appended to this report.

The tertiary trangulation may be treated as in five parts—independent stations; system Chimney-Grenadier; system Grenadier-Alexandria; system Wells No. 2-Dorr Farm; system Darling-Smoke.

From Chimney Point to Oak Point the river is about a mile wide, with islands small and low enough for single channel treatment, with a widening to two miles at Chippewa Point and similar conditions, so that the secondary stations were frequent and a missing station could be neglected or an independent tertiary read in in its place.

Above Chippewa Point, however, the river widens out to four miles, the triangles expand, the stations are fewer, so that the gaps need to be bridged with new stations in order to read in the many plane-table signals needed. By the time the foot of Grenadier Island is reached the river has split into two well-divided channels that need individual treatment and continue this way to the western limit of the resurvey. These geographical conditions determine the tertiary chains noted above.

Each tertiary system is an intermediate system beginning and ending with secondary stations; and hence, being an interior net, there was no occasion for an accuracy exceeding the minimum platting unit of the scale of the plane-table sheets, as indicated by the plane-table signals determined from these stations. The scale of the sheets was 1 in 10,000 and the platting unit of this scale is 10 feet, so that for the purposes of the resurvey no accuracy beyond that unit was indicated. To have attempted any greater precision would have been to retard the other parties. The plane-table parties during the whole season were on the heels of the triangulation party, and to avoid blocking them the most rapid methods of field work and reduction consistent with the scale criterion were demanded. The tertiary triangulation stations and the plane-table signals must be taken as precise only to this extent.

The two stations at Ogdensburg, East Base and 2, are reported as unsatisfactorily located.

In many cases but two angles of a triangle were observed, both for independent stations and in the chains. In the chain Chimney-Grenadier out of 10 triangles, three only had all three angles read, and in the three the average closure was 10 seconds, with a maximum of 19 seconds. The distance closure between terminal secondaries was 5 feet, which was distributed back over the triangles. Not all of the triangles were well proportioned, some angles being as small as 14°. This system was the poorest of the four.

In the chain Grenadier-Alexandria out of 14 triangles, 10 had all angles read. Average triangle closure, 13 seconds; maximum, 35 seconds. The distance closure was 3 feet.

Most of the triangles were well proportioned.

The system Wells No. 2-Door Farm consists of two quadrilaterals and three triangles. Average triangle closure was 9 seconds; maximum, 18 seconds. The distance closure was 7 feet, which was distributed.

The system Darling-Smoke consists of two quadrilaterals and one triangle. Average triangle closure was 12 seconds; maximum, 35 seconds. The distance closure was 3½ feet.

A portion of the triangulation was done with Brandis transit, No. 1799, reading by verniers to 30 seconds; the balance and larger portion, with Pistor and Martin theodolite No. 1323, reading by two micrometer microscopes to seconds by estimation.

Each instrument was used on an ordinary transit tripod, except at stations Grena-

dier, Darling, and Wells No. 2, where 25-foot guyed center posts were used to elevate the instrument.

While the horizon closures were not as good as those on the transit tripod, the triangles containing these stations show no error of closure greater than other triangles.

In observations with the transit a six repetition programme was employed, without horizon closure. In using the theodolite angles were read around the horizon to the left, telescope normal, and to the right, telescope inverted, and three positions on the plate were used. Plane-table signals were usually read in from at least three stations, as a check on positions.

Targets of 2-inch square, planed, unpainted, pine poles, with flags of black and white cloth, were ordinarily used. Where tall signals were needed saplings were used.

Plane-table signals for the most part were taken on existing objects, as chimneys, church spires, gable ends of buildings, light-houses, towers, windmills, prominent trees with and without flags in them, and sometimes flags were set up where existing objects were lacking. One hundred and forty-six plane-table signals were established, in addition to eleven light-houses reestablished and used for signals, and sixty-five triangulation stations so used.

A folio of descriptions of these signals, with latitudes and longitudes, and azimuths from triangulation stations, printed on standard sized tracing cloth, accompany this report. Similar folios of Secondary Triangulation Station References, and Tertiary Triangulation Station References, 1902, and Descriptions of Buoy Stations, 1901, are submitted.

The work of the triangulation party in amount, and in the results under the rush conditions, is worthy of special note. This party, which had taken the field June 6, with Recorder Sherman Moore in charge, assisted by two men ranking as laborers, and aided at times by computers not of the party, despite an exceptional rainy June, had determined enough signals by June 23 to enable a plane-table party to begin work. The party was strengthened August 14 by the transfer of Junior Engineer A. F. Armstrong from the topographical work. These two men, with two assistants accomplished the large amount of field work, made the reductions, and printed the data regarding plane-table signals on tracing linen, ready for blue printing and issue among the topographical and sounding parties.

The party had made such progress that it was possible to detach Recorder Moore from it September 10, to become chief of Plane Table Party No. 3, and Junior Engineer Armstrong completed the work. Mr. Armstrong withdrew from the lake survey November 16, for service in the Philippines.

Toward the last of November and in early December transit determinations of the magnetic declination were made from △ Smoke to Ogdensburg, at about 5-mile intervals.

The first of the plane-table parties, No. 3, had begun work on the topography near Johnstown, on sheet 8, in June; and the second party, No. 4, took the field July 19, about a mile above Nevins Point, working on sheet 9. Junior Engineer Armstrong was placed in general charge of the topography to establish uniform detail methods for the two parties. Recorder Benjamin F. Batchelder was instrument man for Party No. 3, and Recorder Charles A. Pohl for Party No. 4. The work of each party was highly creditable.

Sheets of mounted paper, 30 by 60 inches, had been subjected to alternate damp closet and dry air for about a week; and had then drawn upon them minute latitude and longitude lines in faint sepia, following the polyconic projection; with the plane-table signals indicated by sepia circles, and numbered. These were protected most successfully by a dark-buff, opaque, curtain cloth, which was fitted to the sheet, with holes cut by a wad-cutter over the signal points, and was opened up over the area under development, to be closed again by pasted strips, on passing it. The table was protected from the sun's glare by a large umbrella.

Locations followed the customary methods, and need no comment. Each party consisted of an observer, assistant, two stadiamen, and an umbrella man. The stadia rods used were of two patterns, the diamond pattern used in 1901, and a block and figure pattern. The diamond pattern seemed in most favor with the instrument men.

Each plane-table sheet, as far as Chippewa Point, covered the full river width and its shores, for a length of 8 miles.

With the triangulation party in advance of the two plane-table parties a river length of over 16 miles was covered by the survey parties at one time. As the region was well settled parties were subsisted on the country, each party locating as close to the center of its sheet as was practicable, and getting in and out by small boat, tug, or by team in some few instances.

No statement of the area covered by the topography of 1902 is given, for the reason that area can not be taken as a measure of the work done, since considerable work

consisted of shore line alone, inclosing no area whatever; and many rocks, mere points rising from the river, were taken, which were difficult and slow of access and of almost zero area. Any statement of the square miles of topography taken would, therefore, be misleading as a measure of the efficiency of the plane-table method. Using the transit method on the lower river, and the plane-table on the upper, no difference of opinion existed among the members of the party who had worked both seasons regarding the superiority of the plane table for the country surveyed. The time lost in the field exceeds the time lost in transit work very little, as shown by the following table:

TABLE 2.—*Days lost by reason of bad weather.*

Month.	Plane table parties. No. 3.	Plane table parties. No. 4.	Sounding party No. 5.	Remarks.
1902.				
July	1½			
August		2	2	
September	4½	3	5	
October	1½	3	7	
November	4		4	During 26 days.

Parties 4 and 5 began work late in July and no comparison with the loss of time of Party 3 is therefore given.

During the season 8 plane-table sheets, numbered 8 to 15, corresponding as close as practicable with similar sheets of the old survey, were made on a scale of 1 in 10,000.

Beginning at Johnstown, the topography is practically complete as far as Chippewa Point, covering the limits of the original survey. In the region of Chippewa Bay only the village of Chippewa and the islands were taken; along Oak Island only the north shore line, and the islands north of it, were taken; from the head of Oak Island to Iroquois Point little more than the shore line was taken, but all islands were surveyed; from this point to Clayton the resurvey followed generally the limits of the original survey, except that the interior of Wellesley Island was not penetrated, and only the south shores of Murray and Picton Islands were taken, and Washington Island was not included.

On the Canadian side, as far as the village of Rockport, the resurvey was complete, including Grenadier Island. Above Rockport all islands were completely surveyed as far as Lindoe light, except that only so far as could be seen from the shore was taken on Hill and Wellesley islands; on the mainland the survey extended as far back as the river road, and terminated at the village of Selton.

The topography included the survey of many towns, summer colonies, and settlements. Of these the survey was complete, except for Ogdensburg, Prescott, Brockville, and Alexandria Bay, where main streets were surveyed as bases, and the balance of the town interior, blocks and buildings, compiled from local maps, and afterwards checked by field examination. Complete surveys were made of Wexford, Maitland, Morristown, Union Park, Rockport, Chippewa, Westminster Park, Thousand Island Park, and Grand View Park.

The plane-table parties were disbanded the last of November.

The sounding party took the field July 21, in charge of Junior Engineer R. F. Proctor, using as a sounding craft catamaran No. 3, which had been made self-propelling by putting in it a 12-horsepower gasoline motor manufactured by H. J. Leighton, of Syracuse, N. Y. This gave her a speed of about 5 miles an hour. This craft, which is shown in plate No. 1, is equipped for the most advanced methods of sounding and of position location.

Soundings were taken with a 95-pound cast-iron weight, on No. 12 plow steel wire, leading from a reel 5 feet in circumference, whose revolutions told off the depth, which was read on a scale. Soundings were made every 20 seconds, raising the weight just clear of the bottom between soundings.

The position of the catamaran was read in every minute by transit reading on the stadia mast, using a single instrument.

The party consisted of a chief, a recorder, two transit men, two reel men, and an engineman. Two transit men were used to avoid the loss of time to the catamaran party while the transit man was changing his station. While one transit man was reading angle and distance the other was moving to an advance station, setting up his instrument and preparing to take up the reading when the catamaran came

within his radius; and in this way the work of the catamaran was continuous. Sounding lines were mostly determined by natural ranges, and all shoals were thoroughly developed and least depth found.

Blending with the plane-table work, the sytem of survey permitted the transit man to set up his instrument and determine his location at any place where three or more plane-table signals were visible. Instructions, however, were issued to read in at least five plane-table signals at each set-up, insuring more accurate locations. The catamaran could be located by angle and distance 4,200 feet away. The great number of rocks and small islands big enough for a transit set-up made the stadia system of sounding location possible in the St. Lawrence where it was 4 miles wide from shore to shore.

The re-sounding of the river was not complete, following for the most part traversed channels, but examinations were made in all localities where information indicated uncharted shoals.

Beginning at the head of the Galops Rapids the channel following the north cut was sounded; from Chimney Point to Chippewa Point practically the entire river was re-sounded, except a few inconsequent channels among the islands; above Chippewa Point the main river was re-sounded, excluding Chippewa Bay, and back of Oak Island; from the foot of Grenadier Island the sounding followed the main traveled channels, American and Canadian, to Rock Island and Lindoe lights, including the cross-over at the head of Grenadier Island. Several shoals above Lindoe were examined.

The seasons record shows 51 square miles sounded, with a total of 68,300 soundings. The average day's work was 0.58 square mile, in which 776 soundings were taken, or 1,339 to the mile. Thirty-two new shoals were developed. A description of these shoals and of other developments was prepared by me and was published in Lake Survey Bulletin No. 13.

The soundings as platted on the detail sheets are referred to a river-plane surface corresponding to Lake Ontario Standard Low-Water Plane 243.0. Staff gauges were established at Morristown, Oak Point, Cedar Island, Alexandria Bay, and Rockport, and their zeros determined by simultaneous readings with self-registering gauge No. 12, at Ogdensburg. Readings taken morning and night on one of these staff gauges gave a correction for stage, and this correction as indicated by the morning reading was set off on the reel, so that the indicated depth on the scale was below the datum surface. Where the Ogdensburg gauge indicated any considerable range during the day corrections were applied to the recorded depths to compensate for this. As the slope of the river from Clayton to Ogdensburg is less than a foot, and between Alexandria Bay and Ogdensburg the fall is but half a foot, the fluctuation of gauge No. 12 represented closely the fluctuation over the river stretch involved in the soundings.

The sounding party was disbanded on the night of November 26, after a season of excellent work. The cold November days made work in an open boat a severe test of the endurance of the members of the party.

When the development of the considerable shoal, indicated south of Slim Island by the chart as having a least depth of 8 feet, was attempted, no shoal could be found by the sounding party, and soundings showed upward of 70 feet of water. The area was patrolled by the tug with no better results. As the shoal, if in existence, was close to the channel, it was not considered safe to strike it from the chart without sweeping the area for some isolated peak that might reach up between the soundings. A sweep 330 feet long was constructed, and the area was swept for a depth of 23 feet, insuring the absence of any obstruction. This work was done by the tug and a rowboat and is significant as utilizing a simple and efficient method for the location of submarine obstructions. The sweep is shown in plate No. 2.

Having on hand two gasoline barrels, two buoys, two 95-pound sounding weights, two sounding leads, and some old galvanized iron wire, 330 feet of No. 12 iron wire was purchased, the sweep built, and the area swept in one day. The principle involved is the same as that used in the lake survey method of sounding, namely, that a taut wire may be passed through the water with very little resistance.

In the case of the sounding the wire is vertical; for a sweep the wire must be supported at a fixed depth below the water surface by buoys and held down by weights suspended from the buoys, then drawn taut to take up the sag between supports, and drawn horizontally through the water. Any obstruction encountered is indicated by telltale flags and by vibration in the wire, as in the case of a bar sweep the vibration of the chain or cable indicates a point struck. To apply the tension the boats operating the sweep diverge, and the pull of the boats on the surface lines is transferred almost at right angles to the wire by means of the suspended heavy weights. The tension used on the St. Lawrence varied from 25 to 50 pounds as measured with a

spring balance. It is evident that by the use of very heavy end weights any desired tension may be applied to the wire without sensibly raising the weights.

Letting w be the gravity measure of a submerged weight, and t the tension applied at the surface, the angle a, by which the supporting cable is deflected from the vertical, is derived from the equation Tang $a=t/w$, and the length of the cable must be d X secant a to keep the wire at the ends at a fixed depth.

There are some peculiarities of this sweep worthy of note. It does not block the channel in which it is operating, as vessels may pass between the floats and over the wire; it retains a fixed distance below mean-water surface even when waves are running, because the inertia of the wire prevents the dancing of the buoys; it may be used of great length, a thousand feet or longer; it is inexpensive; when the day's work is done it may be reeled in.

These peculiarities point it out as peculiarly adapted to the work undertaken of sweeping open lake areas. These areas are so great that the longest sweep possible must be used to successfully cover them. It is hoped to develop the best possible form of tension wire sweep in the surveys of this season in the west end of Lake Erie.

At the close of the season's work on the St. Lawrence, the tug and catamaran were laid up in Morristown Harbor for the winter. Aside from the boats and such equipment as the tug could take to Detroit another season, everything was packed and shipped to Detroit, abandoning the Ogdensburg office. On December 12 the winter force consisting of Junior Engineer Proctor, Recorders Pohl and Moore, and myself were transferred to the headquarters office.

During the office season the plane-table sheets were completed and miscellaneous work occupied the party.

Junior Engineer R. F. Proctor, to my regret, left the survey March 31 to engage in civil practice.

During the late winter and spring my personal supervision was given to the remodeling of the steamer *General Williams* to adapt her to the uses of the survey.

Preparations were made and the party left Detroit June 26 for an investigation of shoal areas in the west end of Lake Erie.

Terminal arrangements have been made in Toledo, and the preliminary work of relocating triangulation stations and erecting towers has been entered upon.

Very respectfully,

Francis C. Shenehon,
Assistant Engineer.

Maj. W. L. Fisk,
Corps of Engineers, U. S. Army.

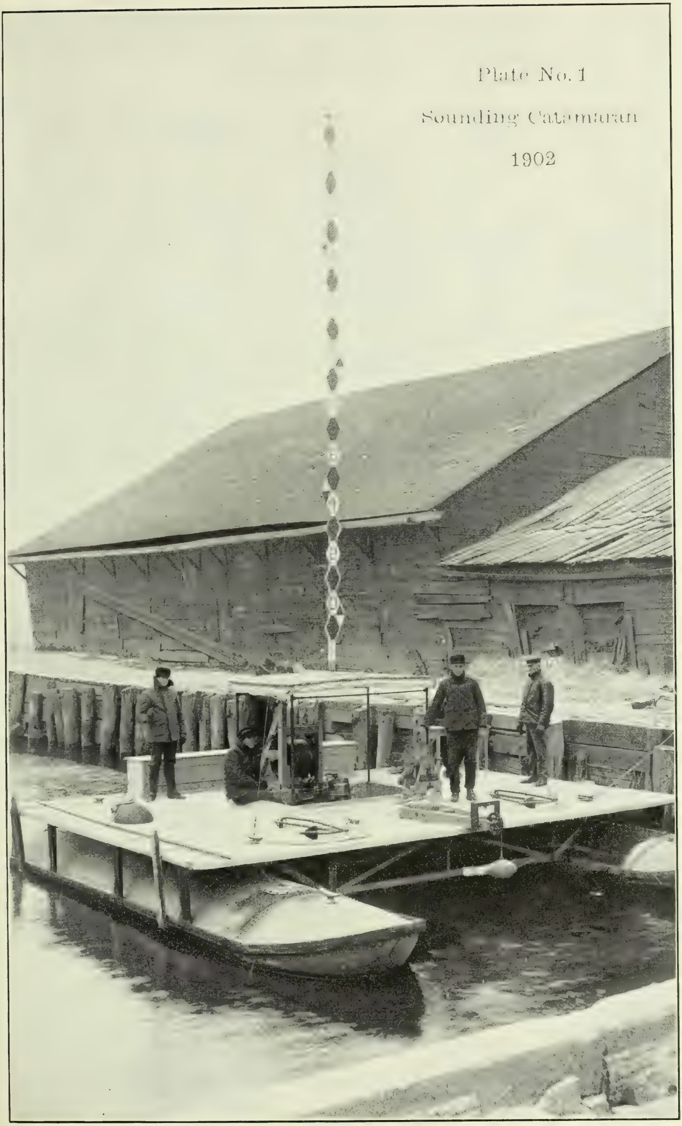
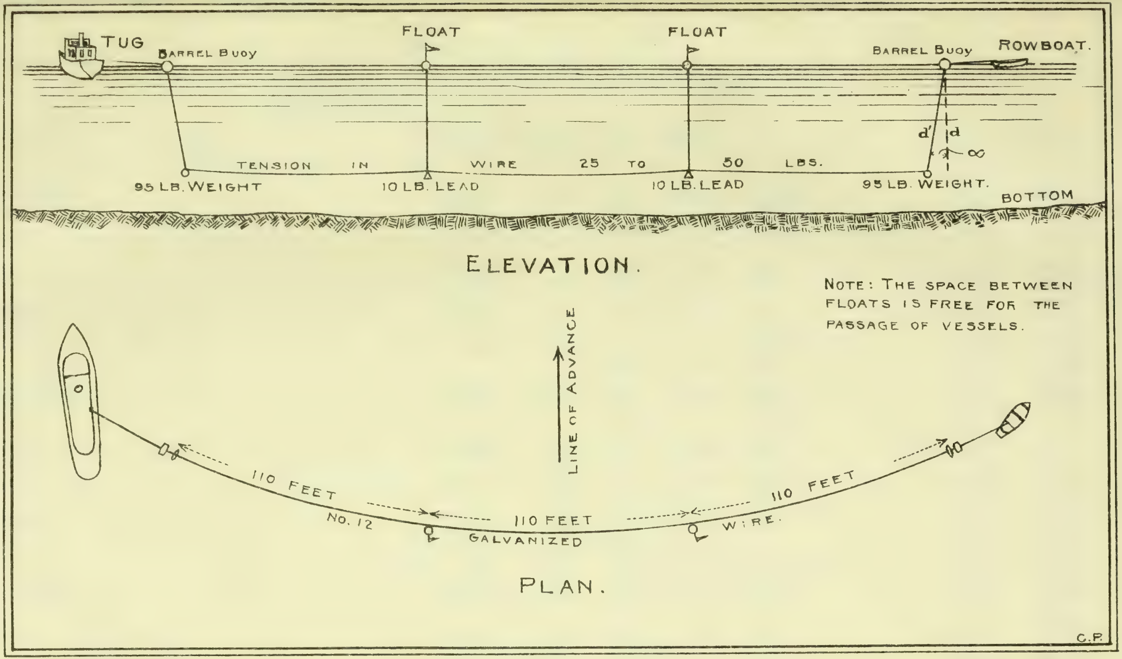


Plate No. 1

Sounding Catamaran

1902

PLATE NO. 2.



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Eng 58 1

RESURVEY OF ST. LAWRENCE RIVER.

Geographic positions, etc., of Tertiary Triangulation Stations, 1902.

[Computed by Sherman Moore, recorder; Francis C. Shenehon, assistant engineer.]

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
East Base, 1902	44 42 33.86	1,045.2	179 34 42	359 34 41	Johnstown	3,594.9	3.5556837
	75 27 58.49	1,287.4	127 30 00	307 29 07	Windmill	2,122.2	3.3267871
2, 1902	44 42 12.88	397.5	177 51 53	357 51 51	Windmill	1,940.5	3.2879209
	75 29 11.70	257.6	249 27 29	69 27 43	West Base	551.1	2.7412456
H, 1902	44 38 31.40	969.3	224 33 32	44 35 07	Nevins	4,237.2	3.6270717
	75 34 36.34	801.0	69 55 31	249 54 06	Maitland	3,178.5	3.5022214
Guernsey	44 40 08.59	265.1	26 10 51	206 10 03	I	5,109.8	3.7084067
	75 34 02.05	45.2	269 31 31	89 32 41	Nevins	2,217.5	3.3458685
Brockville	44 34 48.35	1,492.5	232 55 51	52 57 18	Morristown Point	3,446.5	3.5373722
	75 40 37.86	835.1	51 06 53	231 05 33	Moulson	3,240.6	3.5106209
			210 08 21	30 09 20	Eaton	3,729.8	3.5716838
Chapman, 1902	44 33 32.46	1,002.0	106 51 31	286 50 59	Moulson	1,059.4	3.0250704
	75 41 46.20	1,019.5	44 19 07	224 18 41	Taylor	1,172.1	3.0689504
			212 46 30	32 47 18	Brockville	2,785.6	3.4449253
Cooks Point	44 24 48.25	1,489.3	332 46 31	152 47 01	Grenadier	2,354.2	3.37185
	75 54 20.95	463.5	308 57 38	128 59 43	Turkey	5,211.8	3.71699
Chimney	44 28 10.835	334.4	339 15 43	151 16 54	Lyons '02	6,203.0	3.7926018
	75 50 41.101	908.5	351 13 37	171 13 57	Cherry	4,164.7	3.6195838
Lyons, 1902	44 25 02.88	88.9	67 10 36	247 09 40	Third Brother	1,937.2	3.2871693
	75 49 01.82	40.3	137 12 30	317 11 40	Cherry	2,297.1	3.3611803
Cherry	44 25 57.49	1,774.5	111 47 14	291 46 18	B	2,464.6	3.3917481
	75 50 12.38	273.8	5 15 40	185 15 34	Third Brother	2,447.5	3.3887145
Third Brother	44 24 38.54	1,191.5	72 39 13	252 38 04	Tuesday	2,282.2	3.3583510
	75 50 22.49	497.6	22 20 25	202 19 46	Turkey	3,221.8	3.5080925
Tuesday	44 24 16.49	509.0	250 06 45	70 08 50	Lyons '02	4,213.2	3.6246146
	75 52 00.90	19.9	337 27 12	157 27 42	Turkey	2,489.4	3.3961064
A	44 25 58.63	1,808.7	190 07 00	10 07 22	Chimney	4,144.8	3.6175036
	75 51 14.04	310.6	133 35 20	313 34 51	B	1,276.3	3.1059550

Geographic positions, etc., of Tertiary Triangulation Stations, 1902—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
B	44 26 27.14	837.7	207 18 04	27 18 55	Chimney	3,601.8	3.5565215
	75 51 55.84	1,235.1	38 57 05	218 56 12	Poole	2,655.8	3.4241945
Poole	44 25 20.20	623.4	245 25 27	65 26 49	A	2,852.1	3.4551679
	75 53 11.31	250.2	329 29 38	149 31 11	Turkey	4,950.6	3.6946533
Turkey	44 23 02.00	61.7	111 43 56	291 42 22	Grenadier	3,204.7	3.5057889
	75 51 17.78	393.6	77 42 05	257 39 33	Bluff	4,730.9	3.6749455
			50 51 51	250 50 30	Excelsior	3,072.6	3.4875062
Grenadier	44 23 40.423	1,247.7	202 30 52	22 32 00	B	5,570.6	3.7459015
	75 53 32.288	714.6	188 34 11	8 34 26	Poole	3,114.6	3.4934037
			36 49 35	216 48 41	Bluff	2,742.1	3.4380893
Excelsior	44 21 59.17	1,826.3	112 34 10	292 32 59	Bluff	2,424.7	3.3846609
	75 53 05.40	119.6	41 58 19	221 56 51	T. I. House	4,308.6	3.6343328
			169 13 10	349 12 53	Grenadier	3,181.7	3.5026535
Bluff	44 22 29.30	904.3	60 02 46	240 00 51	Hill	4,181.1	3.6212892
	75 54 46.53	1,030.3	43 04 32	223 02 51	Waterloo	4,803.8	3.6815895
			8 48 52	188 48 35	T. I. House	4,183.4	3.6215234
T. I. House, 1902	44 20 15.37	474.5	124 27 28	304 25 50	Hill	3,616.1	3.5582400
	75 55 15.47	342.8	103 18 58	283 17 34	Waterloo	2,712.7	3.4334063
Alexandria	44 19 39.003	1,203.9	188 08 02	8 08 06	T. I. House	1,134.1	3.0546345
	75 55 22.708	503.1	138 19 08	318 17 34	Hill	4,242.8	3.6276529
Waterloo	44 20 35.60	1,098.9	305 09 10	125 10 44	Alexandria	3,033.4	3.4819340
	75 57 14.64	324.3	166 27 20	346 27 06	Hill	1,461.8	3.1648804
Wells No. 2	44 19 07.734	238.7	345 13 25	165 13 49	St. Lawrence	3,023.1	3.4804488
	75 59 06.630	146.9	222 26 17	42 27 26	Waterloo	3,675.6	3.5653310
			258 58 15	79 00 51	Alexandria	5,054.8	3.7037091
St. Lawrence	44 17 33.03	1,019.5	196 52 48	16 53 33	Waterloo	5,889.5	3.7700801
	75 58 31.85	706.0	227 08 07	47 10 19	Alexandria	5,717.8	3.7572277
			53 53 37	233 52 10	Fisher	3,465.8	3.5398065
Park	44 17 32.13	991.7	269 32 23	89 34 17	St. Lawrence	3,595.7	3.5557835
	76 01 14.03	311.0	223 43 36	43 45 06	Wells	4,084.5	3.6111388
Fisher	44 16 26.84	828.3	158 26 19	338 25 52	Park	2,166.6	3.3357724
	76 00 38.11	845.3	202 12 20	22 13 23	Wells	5,364.3	3.7295121

Garlock	44 15 18.30	564.9	193 15 44	13 16 13	Park	4,244.0	3.6277765
	76 01 57.94	1,285.5	219 54 52	39 55 48	Fisher	2,758.9	3.4407334
Crawford	44 16 18.28	564.1	304 08 05	124 09 32	Garlock	3,297.8	3.5182299
	76 04 00.97	21.5	266 37 08	86 39 31	Fisher	4,507.0	3.6538850
Dorr Farm	44 14 38.003	1,173.0	214 05 03	34 08 01	Wells	10,055.2	4.0023919
	76 03 20.914	464.1	163 59 05	343 58 34	Crawford	3,220.2	3.5078857
			235 56 46	55 57 42	Garlock	2,221.5	3.3466495
Hill	44 21 21.65	668.3	163 58 40	343 58 25	Darling	1,748.4	3.2426309
	75 57 30.10	666.7	56 24 23	236 23 14	Rift	2,635.9	3.4209330
Darling	44 22 16.073	496.1	28 37 06	208 36 12	Rift	3,575.7	3.5533650
	75 57 51.904	1,149.2	68 34 57	248 30 30	Smoke	9,065.8	3.9574070
Echo	44 21 56.36	1,739.6	247 51 12	67 51 59	Darling	1,614.3	3.2079881
	75 58 59.44	1,316.1	298 26 48	118 27 50	Hill	2,250.0	3.3521708
Rift	44 20 34.38	1,061.2	184 54 08	4 54 15	Echo	2,540.6	3.4049330
	75 59 09.22	204.2	51 28 06	231 27 04	Wind	2,590.8	3.4134370
Wind	44 19 42.10	1,299.5	208 24 35	28 25 44	Echo	4,713.5	3.6733478
	76 00 40.68	901.3	140 42 50	320 41 18	Rock	4,621.4	3.6647792
Rock	44 21 37.96	1,171.7	263 41 38	83 44 19	Echo	5,200.0	3.7160050
	76 02 52.83	1,169.8	291 35 28	111 38 02	Rift	5,327.1	3.7264929
Smoke	44 20 28.643	884.1	286 58 16	107 00 42	Wind	4,916.0	3.6916145
	76 04 12.897	285.7	219 38 39	39 39 34	Rock	2,779.1	3.4439070

REPORT OF MR. F. G. RAY, JUNIOR ENGINEER.

UNITED STATES LAKE SURVEY OFFICE,
Detroit, Mich., April 29, 1903.

MAJOR: I have the honor to report field operations of party working under my immediate charge during the season of 1902, as follows:

Complying with your instructions, the writer with assistants W. R. Caldwell, junior engineer, and W. H. Vandeburgh, recorder, and boat crew of 11, left Detroit, Mich., on U. S. S. *Search*, May 29, 1902, to resume the resurvey of the Apostle Islands in Lake Superior. The party arrived at Bayfield, Wis., on June 6, after procuring instruments and camp equipage from the United States Engineer warehouse at Duluth, Minn.

The party was augmented during the first week by the reporting of Recorders Wellington Roberts, Ira C. Sunderland, H. S. Ripley, and Nelson C. Morrow, and five additional men, making a party of 23.

Field work began on June 10. The operations from June 10 to October 15 consisted of triangulation, topography, and hydrography, continued to the northward and westward of the previous year's work, completing a thorough resurvey of the Apostle Islands and adjacent waters lying north of Chequamegon Bay.

The methods employed during the previous year and described on page 2839, Chief of Engineer's Report of 1902, were followed in the main and will not be repeated.

The character of the hydrography required closer investigation, and consequently comprised the greater and most important part of the season's work.

Triangulation.—The secondary triangulation was carried west from line Oak No. 2—North Twin to Eagle Island, locating one or more permanent stations on each island, and connecting on station Detour of primary triangulation of Lake Superior. Most of the angles were read by Mr. Caldwell. There were 17 new stations located, and three 32-foot, one 16-foot, and nine 5-foot observing stations built. Nineteen triangles were closed with an average discrepancy of 1.69 seconds in closure. Eleven close large, average 1.76 seconds, and eight small, average 1.57 seconds.

A careful reconnoissance failed in dispensing with some heavy cutting on two or three lines. Otherwise no trouble was experienced in laying out a satisfactory system.

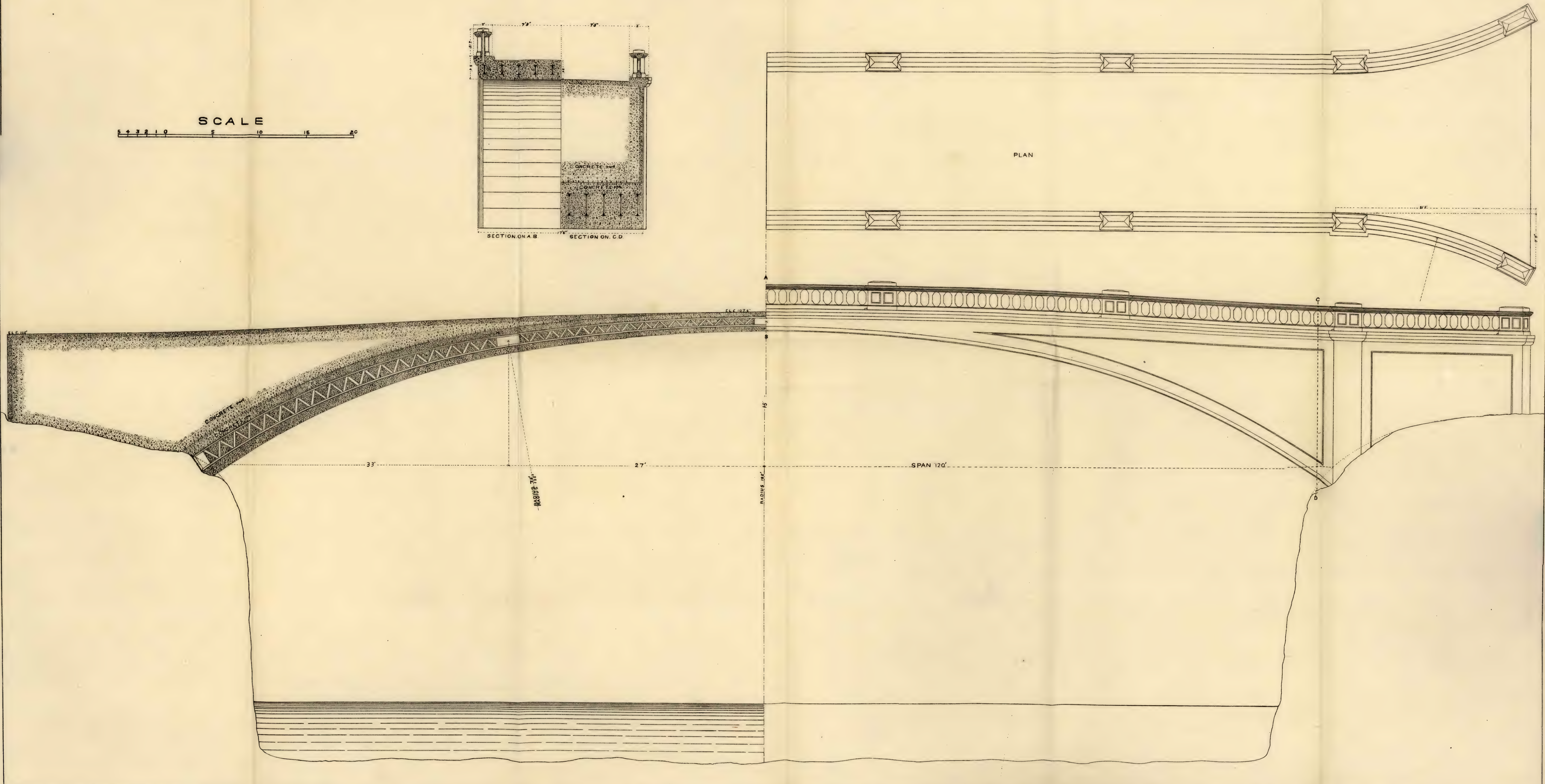
The coordinates of the 1901 triangulation as given in my report and published in Chief of Engineer's Report of 1902 are referred to Oak No. 2, using the value found on original computation sheets on record in this office, and making a correction corresponding to the correction at Outer Island (primary). This record does not give the method of location of Oak No. 2, but shows that there is a large discrepancy in two separate locations. The adjusted value was used.

In comparing the results of the new triangulation with the old, it is found that it would be necessary to make an adjustment of 1 in 6620 in distance and 27 seconds in azimuth to make the coordinates of Oak No. 2 and Detour agree. Knowing that the results of the old secondary triangulation are quite unreliable, and that the inaccuracies of the present work are far within these limits, no attempt is made to harmonize the two. Coordinates are revised to agree with the position of Detour. A rough check for azimuth was obtained by reading 5 sets of angles at station Detour to target at primary station Split Rock. The result showed the azimuth as derived from the secondary triangulation 4.14 seconds larger than the primary azimuth. The elevations of these stations necessitated a condition of abnormal refraction to make them intervisible. A rigid connection could have been made by an indefinite delay to the other work, but this was not thought advisable. The observations being few and not made under very good conditions, were not considered of sufficient weight to warrant any adjustment of the triangulation.

Appended hereto is a sketch of the entire system of triangulation; Table 1, computation of triangle sides, 1902; Table 2, the revised geographical positions and azimuths of secondary stations; Table 3, geographical positions of tertiary points with brief descriptions, and a list of descriptions of secondary stations located in 1902.

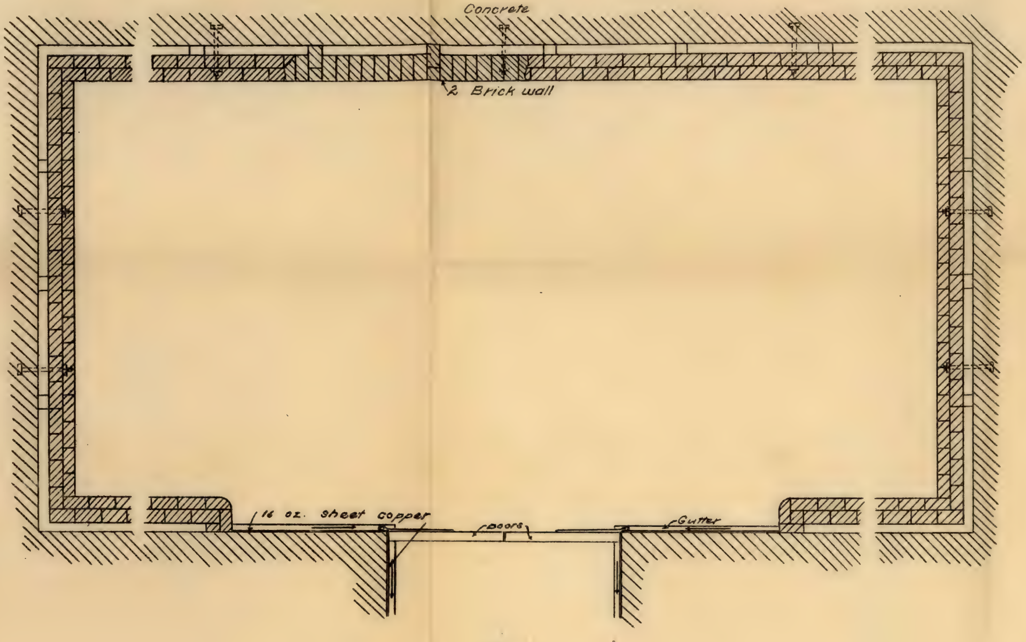
The geographical coordinates in these tables are revised to depend on the United States standard coordinates of primary station Detour and astronomic azimuth of line Pike-Bayfield.

NEW GOLDEN GATE VIADUCT.

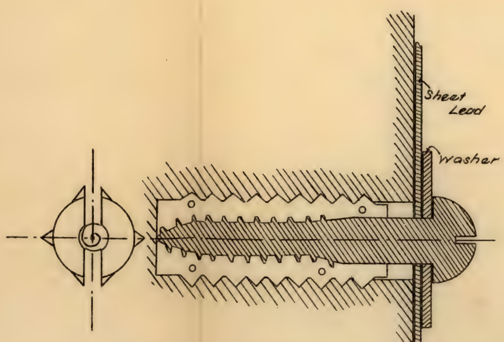


THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

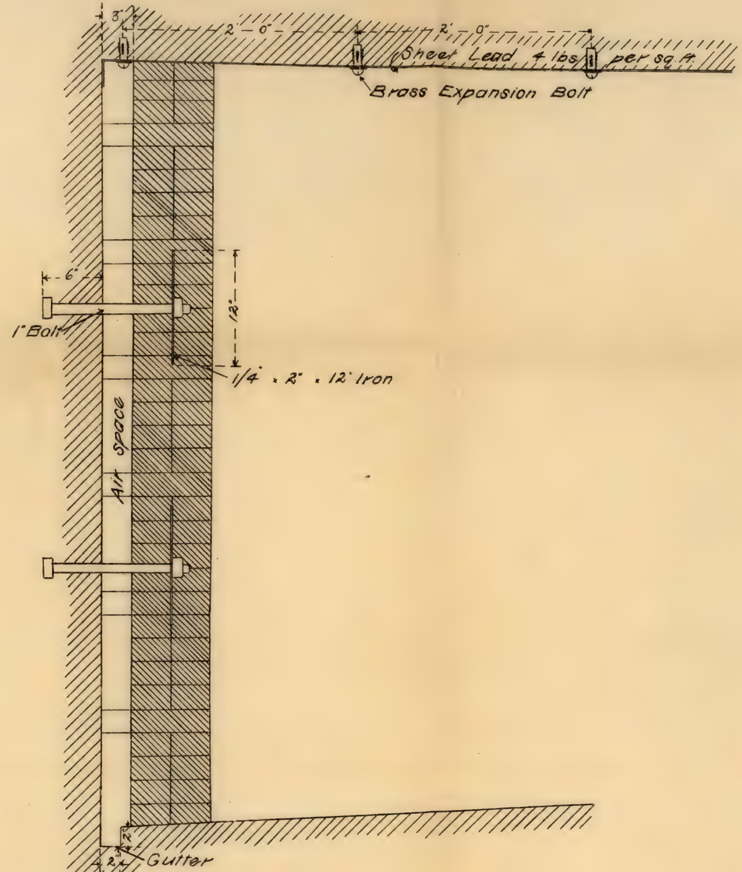
under



Plan

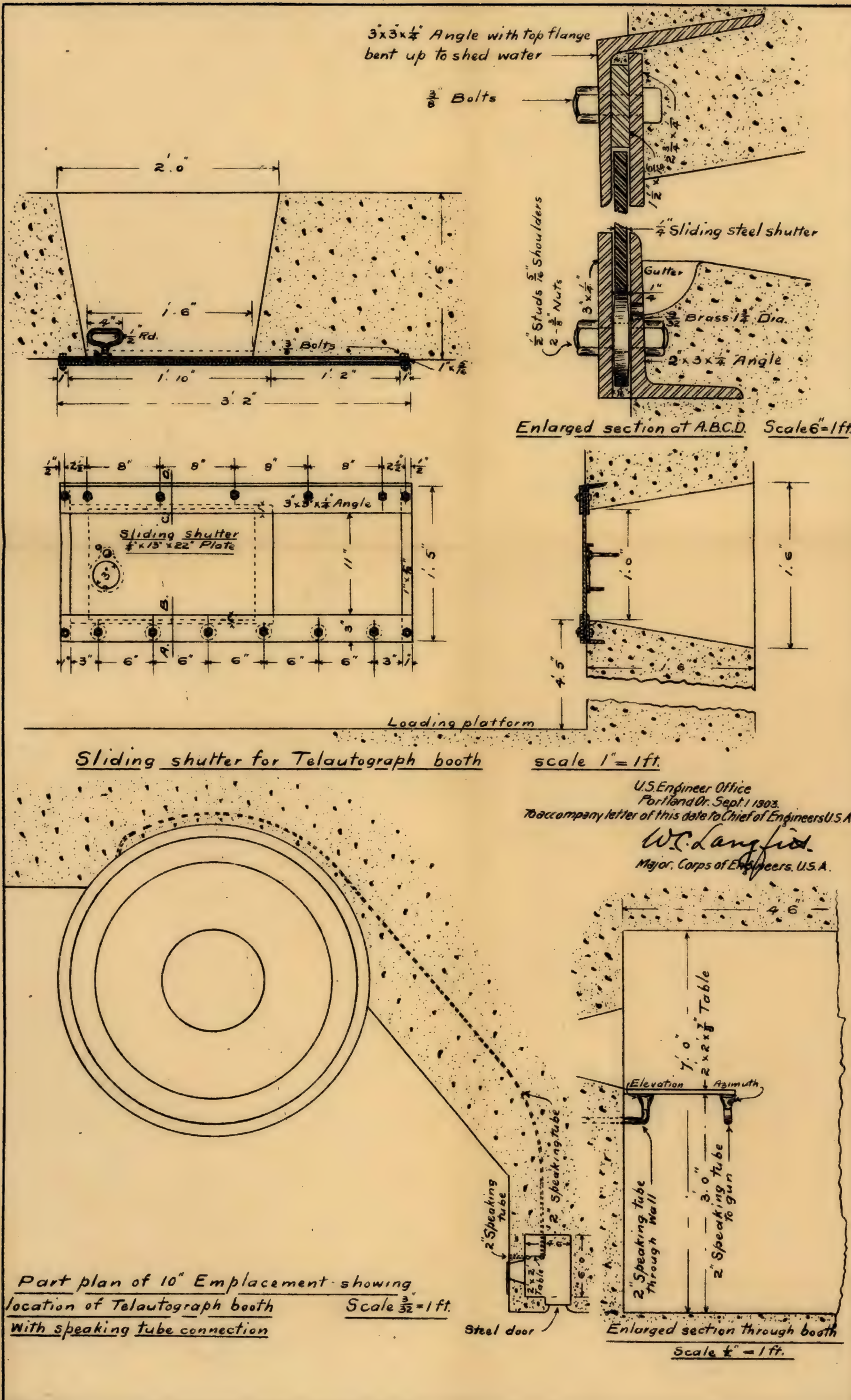


Expansion Bolt for sheet lead and copper
Full size

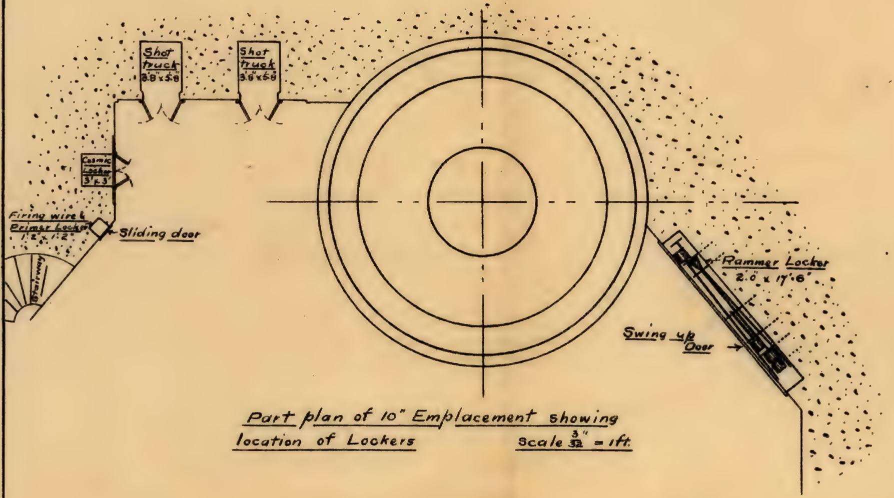


Cross section
1 inch = 1 foot

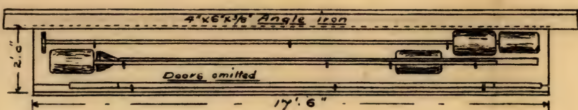
Sketch showing
Method of Lining Damp Magazines
at
Fort St. Philip, La.
Drawn under the direction of Lieut. Col. H. M. Adams, Corps of Engineers, U. S. A.
by J. G. Ross, Junior Engineer
June, 1903
Scale: 1 inch = 3 feet

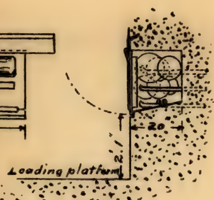


ANDREW B GRAHAM PHOTO-LITHO WASHINGTON D.C.

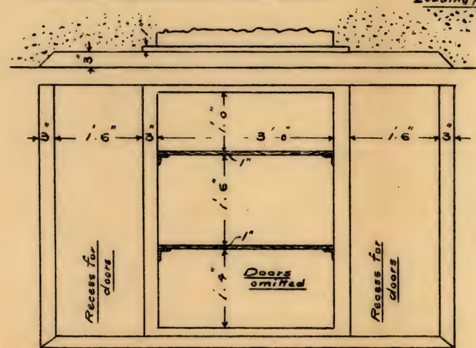


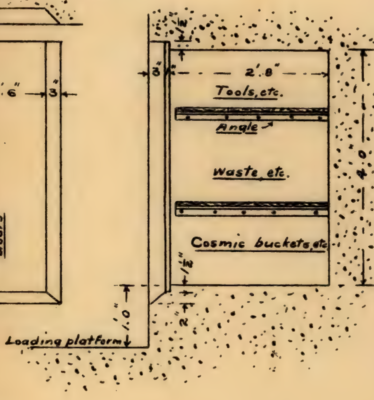
Part plan of 10" Emplacement showing location of Lockers Scale $\frac{3}{32}$" = 1ft.



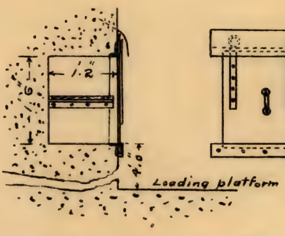


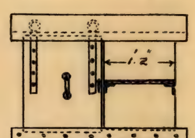
Rammer Locker Scale $\frac{1}{4}$" = 1ft.





Cosmic Locker scale $\frac{1}{2}$" = 1ft.





Firing-wire and primer Locker scale $\frac{1}{2}$" = 1ft.

U.S. Engineer Office
Portland Or. Sept. 1 1903.
To accompany letter of this date to Chief of Engineers U.S.A.
W. C. Langfitt
Major. Corps of Engineers U.S.A.

TABLE I.—*Computation of triangle sides.*

Stations.	Observed angles.	Corrections.	Adjusted spherical angles.	Plane angles.	Log. sines.	Log. sides.	Sides.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	*Meters.*
Devils	87 53 54.69	−0.55	87 53 54.14	87 53 54.01	9.9997078	4.2302113	16,990.70
North Twin	54 07 11.70	− .56	54 07 11.14	54 07 11.02	9.9086156	4.1391191	13,775.87
Oak No. 2	37 58 55.65	− .56	37 58 55.09	37 58 54.97	9.7891667	4.0196702	10,463.34
	2.04	−1.67					
Sand No. 1	47 52 40.10	− .33	47 52 39.77	47 52 39.59	9.8702367	4.1391191	13,775.87
Devils	63 47 16.21	− .33	63 47 15.88	63 47 15.70	9.9528716	4.2217540	16,663.03
Oak No. 2	68 20 05.22	− .33	68 20 04.89	68 20 04.71	9.9681821	4.2370645	17,260.94
	1.53	− .99					
Rock	99 17 51.23	− .44	99 17 50.79	99 17 50.72	9.9942569	4.2370645	17,260.94
Sand No. 1	60 17 17.54	− .44	60 17 17.10	60 17 17.02	9.9387839	4.1815915	15,191.18
Devils	20 24 52.78	− .44	20 24 52.34	20 24 52.26	9.5425883	3.7853959	6,100.93
	1.55	−1.32					
Oak No. 3	96 34 10.89	+1.19	96 34 12.08	96 34 12.00	9.9971385	4.1815915	15,191.18
Rock	46 45 10.18	+1.19	46 45 11.37	46 45 11.28	9.8623749	4.0468279	11,138.53
Devils	36 40 35.62	+1.19	36 40 36.81	36 40 36.72	9.7761935	3.9606465	9,133.70
	56.69	+3.57					
Bear	81 30 36.25	+ .52	81 30 36.77	81 30 36.73	9.9952148	3.9606465	9,133.70
Oak No. 3	67 32 22.38	+ .51	67 32 22.89	67 32 22.86	9.9657407	3.9311724	8,534.39
Rock	30 56 59.93	+ .51	30 57 00.44	30 57 00.41	9.7112094	3.6766411	4,749.43
	58.56	+1.54					
Raspberry	92 08 23.56	+1.58	92 08 25.14	92 08 25.15	9.9996969	3.6766411	4,749.43
Bear	48 45 58.22	+1.58	48 45 59.80	48 45 59.79	9.8762357	3.5531799	3,574.21
Oak No. 3	39 05 33.51	+1.58	39 05 35.09	39 05 35.08	9.7997416	3.4766858	2,996.99
	55.29	+4.74					
Sand No. 2	90 35 42.73	− .72	90 35 42.01	90 35 41.99	9.9999766	3.7853959	6,100.93
Sand No. 1	58 35 25.51	+ .11	58 35 25.62	58 35 25.61	9.9311851	3.7166044	5,207.20
Rock	30 48 53.24	− .83	30 48 52.41	30 48 52.40	9.7094914	3.4949107	3,125.44
	1.48	−1.44					

TABLE I.—*Computation of triangle sides*—Continued.

Stations.	Observed angles.	Corrections.	Adjusted spherical angles.	Plane angles.	Log. sines.	Log. sides.	Sides.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	*Meters.*
York	35 18 02.90	− .05	35 18 02.85	35 18 02.84	9.7618293	3.4949107	3,125.44
Sand No. 2	65 55 50.19	+ .11	65 55 50.30	65 55 50.29	9.9604957	3.6935771	4,938.30
Sand No. 1	78 46 06.83	+ .06	78 46 06.89	78 46 06.87	9.9916019	3.7246833	5,304.98
	59.92	+ .12					
York	110 31 57.89	−1.05	110 31 56.84	110 31 56.83	9.9714956	3.7853959	6,100.93
Sand No. 1	20 10 41.32	− .05	20 10 41.27	20 10 41.26	9.5377438	3.3516441	2,247.21
Rock	49 17 22.91	− .99	49 17 21.92	49 17 21.91	9.8796771	3.6935774	4,938.30
	2.12	−2.09					
Sand No. 2	24 39 52.54	− .83	24 39 51.71	24 39 51.70	9.6204504	3.3516441	2,247.21
York	75 13 54.99	− .99	75 13 54.00	75 13 53.99	9.9854105	3.7166042	5,207.20
Rock	80 06 16.15	−1.83	80 06 14.32	80 06 14.31	9.9934897	3.7246834	5,304.98
	3.68	−3.65					
Sand River	71 50 59.00	− .14	71 50 58.86	71 50 58.84	9.9778345	3.7246834	5,304.98
Sand No. 2	73 29 02.04	− .15	73 29 01.89	73 29 01.88	9.9817007	3.7285496	5,352.41
York	34 39 59.44	− .15	34 39 59.29	34 39 59.28	9.7549582	3.5018071	3,175.46
	0.48	− .44					
Detour	40 53 34.63	− .49	40 53 34.14	40 53 34.13	9.8160065	3.5018071	3,175.46
Sand River	50 34 15.92	− .49	50 34 15.43	50 34 15.42	9.8878487	3.5736493	3,746.70
Sand No. 2	88 32 10.96	− .50	88 32 10.46	88 32 10.45	9.9998582	3.6856588	4,849.07
	1.51	−1.48					
Sand No. 3	72 29 51.56	+ .11	72 29 51.67	72 29 51.66	9.9794140	3.6856588	4,849.07
Sand River	24 26 21.08	+ .11	24 26 21.19	24 26 21.18	9.6167146	3.3229594	2,103.58
Detour	83 03 47.07	+ .10	83 03 47.17	83 03 47.16	9.9968092	3.7030540	5,047.24
	59.71	+ .32					
Eagle	21 55 17.88	+ .29	21 55 18.17	21 55 18.16	9.5721038	3.3229594	2.103.58
Sand No. 3	63 12 34.56	+ .29	63 12 34.85	63 12 34.84	9.9506870	3.7015426	5,029.71
Detour	94 52 06.73	+ .28	94 52 07.01	94 52 07.00	9.9984302	3.7492858	5,614.17
	59.17	+ .86					

Cat	108 52 51.43	+ .41	108 52 51.84	108 52 51.79	9.9759794	4.0767337	11,932.56
North Twin	36 00 01.28	+ .42	36 00 01.70	36 00 01.66	9.7692235	3.8699778	7,412.72
Outer No. 1	35 07 06.17	+ .42	35 07 06.59	35 07 06.55	9.7598712	3.8606255	7,254.80
	58.88	+1.25					
Rocky	50 40 54.60	−1.14	50 40 53.46	50 40 53.42	9.8885365	3.8606255	7,254.80
Cat	47 15 57.54	−1.14	47 15 56.40	47 15 56.36	9.8659965	3.8380855	6,887.88
North Twin	82 03 11.40	−1.13	82 03 10.27	82 03 10.22	9.9958089	3.9678979	9,287.48
	3.54	−3.41					
Ironwood	74 51 25.50	− .66	74 51 24.84	74 51 24.82	9.9846517	3.8380855	7,254.80
Rocky	60 38 40.00	− .65	60 38 39.35	60 38 39.32	9.9403136	3.7937474	6,219.38
North Twin	44 29 56.54	− .65	44 29 55.89	44 29 55.86	9.8456529	3.6990867	5,001.34
	2.04	−1.96					
Otter	79 47 02.38	+ .09	79 47 02.47	79 47 02.45	9.9930596	3.6990867	5,001.34
Rocky	50 50 40.20	+ .10	50 50 40.30	50 50 40.29	9.8895455	3.5955728	3,940.69
Ironwood	49 22 17.17	+ .10	49 22 17.27	49 22 17.26	9.8802115	3.5862384	3,856.90
	59.75	+ .29					
South Twin	74 02 20.15	− .30	74 02 19.85	74 02 19.83	9.9829260	3.8606255	7,254.80
North Twin	63 48 29.15	− .30	63 48 28.85	63 48 28.82	9.9529474	3.8306469	6,770.91
Cat	42 09 11.68	− .30	42 09 11.38	42 09 11.35	9.8267967	3.7044962	5,064.03
	0.98	− .90					

TABLE II.—*Positions, azimuths, and lengths, United States standard datum, secondary triangulation, Apostle Islands.*

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To stations.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
West Ashland, 1901 ... d. m.	46 34 28.476	879.3	245 45 42.20	65 46 40.90	Beaser Avenue School	1,886.89	3.2757457
	90 54 58.762	1,251.2	232 03 02.50	52 04 12.60	Ashland post-office	2,605.76	3.4159339
			231 14 10.90	51 15 40.10	Ashland Catholic spire	3,351.26	3.5252084
			135 24 03.50	315 22 21.50	Nash Schoolhouse	4,258.35	3.6292415
			184 14 37.00	4 15 04.20	Garfield School, Washburn	10,747.82	4.0313204
			187 53 45.00	7 54 39.90	Walker High School, Washburn.	11,688.18	4.0677470
			189 06 31.60	9 07 34.10	Court-house, Washburn	11,548.51	4.0625259

TABLE II.—*Positions, azimuths, and lengths, United States standard datum, secondary triangulation, Apostle Islands*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To stations.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Nash, 1901 ....d. m..	46 37 09.098	281.0	349 18 05.43	169 18 37.40	West Ashland	5,047.43	3.7030702
	90 55 42.764	909.9	327 35 00.76	....	Beaser Avenue School	4,957.27	3.6952425
			318 17 38.40	....	Ashland post-office	4,496.48	3.6528724
			308 52 04.50	....	Ashland Cathedral spire	4,559.22	3.6588902
Breakwater, 1901 ....d. m..	46 37 24.890	768.6	39 34 23.92	219 31 50.35	West Ashland	7,064.93	3.8491077
	90 51 27.401	583.0	84 53 49.89	264 50 44.28	Nash	5,454.98	3.7367935
			32 27 05.60	212 25 42.20	Ashland post-office	4,556.29	3.6586110
			29 23 06.90	209 22 02.50	Ashland Catholic spire	3,843.97	3.5847803
			72 09 03.20	252 04 47.50	Nash School	7,867.19	3.8958199
			144 57 22.50	....	Garfield School	6,439.42	3.8088468
			154 47 10.90	....	Walker High School	6,776.04	3.8309762
			155 54 01.90	....	Court-house	6,524.48	3.8145457
Washburn, 1901 ....d. m..	46 40 49.406	1,525.6	351 54 57.12	171 55 27.78	Breakwater	6,378.55	3.8047221
	90 52 09.562	203.2	33 42 10.29	213 39 35.26	Nash	8,175.19	3.9124978
			9 43 09.30	189 42 05.00	Beaser Avenue School	11,147.96	4.0471953
			5 50 28.50	....	Ashland Cathedral spire	....	....
			8 39 29.20	....	Ashland post-office	....	....
			230 08 58.50	....	La Pointe light-house	....	....
Oak Point, 1901 ....d. m..	46 39 52.356	1,616.7	57 15 46.05	237 11 44.21	Breakwater	8,412.63	3.9249316
	90 45 54.791	1,164.8	102 30 27.38	282 25 54.76	Washburn	8,158.64	3.9116179
			93 51 44.00	273 45 35.50	Garfield School	10,792.22	4.0331106
			99 02 33.00	278 56 52.30	Walker High School	10,081.02	4.0035044
			98 14 22.40	278 08 49.30	Court-house	9,834.98	3.9927736
			96 28 16.20	....	Congregational Church	....	....
			154 42 03.70	....	Chequamegon Point light	....	....
East Ashland, 1901 ....d. m..	46 36 49.229	1,520.2	160 35 20.06	340 33 50.65	Washburn	7,863.93	3.8956399
	90 50 06.590	140.2	223 25 05.55	43 28 08.62	Oak Point	7,788.32	3.8914438
			139 39 05.90	....	Garfield School	....	....
			145 25 32.80	....	Congregational Church	....	....
			148 10 02.90	....	Court-house	....	....
			147 31 18.60	....	Walker High School	....	....
			188 48 34.80	....	Chequamegon Point light	....	....
			196 42 25.50	....	La Pointe light-house	....	....
Houghton, 1901 ....d. m..	46 41 49.173	1,518.4	297 37 24.75	117 41 20.39	Oak Point	7,771.28	3.8904927
	90 51 18.672	396.7	350 35 47.44	170 36 39.86	East Ashland	9,387.84	3.9725658
			1 18 12.94	181 18 06.60	Breakwater	8,162.86	3.9118424
			224 57 37.60	44 59 37.90	Chequamegon Point light	4,968.16	3.6961955
			236 37 29.70	56 40 33.90	La Pointe light-house	6,432.68	3.8083918

Long Island, 1901 .... d. m..	46 43 47.809	1,476.3	342 40 40.48	162 41 58.10	Oak Point	7,615.54	3.8817008
	90 47 41.449	880.1	51 34 19.64	231 31 41.52	Houghton	5,891.34	3.7702139
			171 05 24.70	....	Bayfield Catholic spire	....	....
			185 45 16.70	....	La Pointe Church spire	....	....
Onion, 1901 .... d. m..	46 45 56.106	1,732.5	305 59 31.01	126 02 37.99	Long Island	6,737.21	3.8284803
	90 51 58.169	1,234.2	353 43 10.64	173 43 39.40	Houghton	7,671.12	3.8848591
			313 22 26.00	133 24 55.20	Chequamegon Point light	5,983.42	3.7769495
			303 20 20.50	....	La Pointe light-house	7,433.90	3.8712165
La Pointe, 1901 .... d. m..	46 46 56.640	1,749.0	4 47 39.55	184 47 22.77	Long Island	5,851.45	3.7672634
	90 47 18.417	390.7	72 32 49.48	252 29 25.64	Onion	6,222.69	3.7939784
			14 53 57.50	....	Chequamegon Point light-house.	6,187.81	3.7915369
			60 06 31.30	....	La Pointe Schoolhouse	169.41	2.2289518
Pike, 1901 .... d. m..	46 47 44.506	1,374.4	294 39 23.61	114 41 14.18	La Pointe	3,541.07	3.5491341
	90 49 50.126	1,063.1	339 30 06.46	159 31 40.19	Long Island	7,802.52	3.8922351
			39 04 15.07	219 02 41.76	Onion	4,310.80	3.6345576
			334 50 40.60	154 52 40.40	La Pointe light-house	8,214.23	3.9145669
			296 57 10.10	116 58 55.60	La Pointe Schoolhouse	3,445.64	3.5372702
			210 35 09.60	30 35 52.60	Bayfield Catholic spire	2,457.66	3.3905224
Bayfield, 1901 .... d. m..	46 49 28.553	881.7	350 19 09.53	170 19 37.03	La Pointe	4,758.75	3.6774925
	90 47 56.140	1,190.0	36 57 43.01	216 56 19.90	Pike	4,020.39	3.6042679
			352 12 34.00	172 12 56.50	La Pointe School	4,819.92	3.6830394
			35 26 12.60	215 25 30.60	Power house stack	2,103.82	3.3230093
Madeline No. 1, 1901 .... d. m..	46 47 17.805	549.8	103 42 54.47	283 40 58.22	Pike	3,481.61	3.5417801
	90 47 10.641	225.7	166 33 56.67	346 33 23.50	Bayfield	4,151.10	3.6181631
Madeline No. 2, 1901 .... d. m..	46 47 50.595	1,562.4	67 07 36.70	247 06 14.26	Madeline No. 1	2,603.76	3.4156016
	90 45 17.536	371.9	88 09 53.01	268 06 34.31	Pike	5,784.00	3.7622281
			131 59 20.33	311 57 24.69	Bayfield	4,523.01	3.6554274
			105 58 52.60	285 56 15.00	Power house stack	4,766.83	3.6782298
			113 04 32.30	293 01 56.60	Bayfield Catholic spire	4,922.30	3.6921680
Basswood, 1901 .... d. m..	46 49 55.355	1,709.4	350 47 19.91	170 47 41.39	Madeline No. 2	3,902.82	3.5913779
	90 45 46.995	996.0	73 11 23.53	253 09 49.34	Bayfield	2,859.61	3.4563064
South Base, 1901 .... d. m..	46 50 21.402	660.9	290 57 16.81	110 58 29.06	Basswood	2,248.13	3.3518205
	90 47 26.056	552.2	21 20 34.27	201 20 12.33	Bayfield	1,752.12	3.2435631
Red Cliff, 1901 .... d. m..	46 51 40.127	1,239.1	336 01 26.26	156 02 15.79	Basswood	3,540.72	3.5490916
	90 46 54.883	1,162.5	15 12 06.53	195 11 43.79	South Base	2,519.13	3.4012510
North Base, 1901 .... d. m..	46 51 31.024	958.0	255 39 01.97	75 39 39.84	Red Cliff	1,134.69	3.0548780
	90 47 46.780	990.9	348 27 16.73	168 27 31.85	South Base	2,194.29	3.3412932
Madeline No. 3, 1901 .... d. m..	46 49 11.602	358.3	51 01 23.75	230 59 37.50	Madeline No. 2	3,975.59	3.5994018
	90 42 51.800	1,098.1	94 40 10.16	274 36 28.23	Bayfield	6,472.39	3.8110645
			110 00 38.95	289 58 31.20	Basswood	3,951.53	3.5967667

TABLE II.—*Positions, azimuths, and lengths, United States standard datum, secondary triangulation, Apostle Islands*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To stations.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Oak No. 1, 1901 ... d. m..	46 54 59.454	1,836.0	6 07 46.93	186 07 07.22	Madeline No. 3	10,803.27	4.0335554
	90 41 57.382	1,214.2	36 40 10.49	216 35 48.67	Bayfield	12,733.39	4.1049441
Hermit No. 1, 1901 ... d. m..	46 52 55.788	1,722.8	298 34 57.70	118 36 54.37	Madeline No. 4	3,855.67	3.5861004
	90 40 40.058	848.1	21 58 16.36	201 56 40.24	Madeline No. 3	7,464.28	3.8729882
Madeline No. 4, 1901 ... d. m..	46 51 56.021	1,730.0	50 37 07.57	230 33 34.86	Madeline No. 3	7,997.16	3.9029359
	90 38 00.204	4.3	138 28 08.93	318 25 15.78	Oak No. 1	7,569.51	3.8790675
North Basswood, 1901 ... d. m..	46 52 20.812	642.7	202 46 25.85	22 47 36.82	Oak No. 1	5,313.43	3.7253751
	90 43 34.583	732.4	276 08 09.83	96 12 13.86	Madeline No. 4	7,123.07	3.8526673
Frog, 1901 ... d. m..	46 53 15.838	489.1	231 02 31.85	51 04 48.46	Oak No. 1	5,090.97	3.7068008
	90 45 04.468	94.6	311 44 55.86	131 46 01.47	North Basswood	2,551.43	3.4067831
Presque Isle No. 1, 1901 ... d. m..	46 54 25.580	789.9	352 39 01.82	172 39 22.35	Madeline No. 4	4,656.65	3.6680733
	90 38 28.327	599.5	103 19 25.32	283 16 52.65	Oak No. 1	4,546.00	3.6576293
Hermit No. 2, 1901 ... d. m..	46 53 40.664	1,255.7	138 32 32.11	318 31 17.93	Oak No. 1	3,246.92	3.5114719
	90 40 15.791	334.3	238 36 55.29	58 38 13.76	Presque Isle No. 1	2,664.14	3.4255576
			280 59 40.00	101 07 18.10	Michigan Island light-house	13,538.73	4.1315778
			318 21 57.92	138 23 36.89	Madeline No. 4	4,322.59	3.6357444
Madeline No. 5, 1901 ... d. m..	46 52 28.206	871.0	118 21 14.78	298 18 51.72	Hermit No. 2	4,714.35	3.6734220
	90 36 59.807	1,266.5	152 40 05.36	332 39 00.72	Presque Isle No. 1	4,080.31	3.6106929
Presque Isle No. 2, 1901 ... d. m..	46 54 56.206	1,735.7	22 32 27.88	202 31 22.49	Madeline No. 5	4,947.94	3.6944243
	90 35 30.239	639.9	68 55 23.69	248 51 55.17	Hermit No. 2	6,478.22	3.8114559
			29 43 24.91	209 41 35.43	Madeline No. 4	6,406.20	3.8066003
Michigan, 1901 ... d. m..	46 53 10.056	310.6	82 03 56.44	261 58 38.59	Madeline No. 5	9,310.75	3.9689845
	90 29 44.348	938.9	114 09 15.36	294 05 02.80	Presque Isle No. 2	8,021.56	3.9042589
Presque Isle No. 3, 1901 ... d. m..	46 56 02.012	62.2	337 17 14.49	157 18 31.15	Michigan	5,755.97	3.7601183
	90 31 29.318	620.2	46 41 12.78	226 37 11.45	Madeline No. 5	9,618.68	3.9831154
Gull, 1901 ... d. m..	46 54 25.917	800.3	59 45 06.28	239 42 47.83	Michigan	4,647.67	3.6672351
	90 26 34.718	734.7	115 29 13.19	295 25 38.01	Presque Isle No. 3	6,903.63	3.8390773
			74 42 15.05	254 34 38.71	Madeline No. 5	13,723.50	4.1374649
Outer No. 1, 1901 ... d. m..	46 59 34.786	1,074.2	349 40 04.52	169 41 04.56	Gull	9,694.96	3.9865460
	90 27 56.878	1,201.8	10 50 32.88	190 49 14.36	Michigan	12,096.11	4.0826456
			34 22 34.83	214 19 59.55	Presque Isle No. 3	7,958.95	3.9008557

Oak No. 2, 1901 .... d. m..	46 56 19.647	606.7	252 57 32.88	73 08 56.66	Outer No. 1	20,674.48	4.3154345
	90 43 32.358	684.4	288 23 30.55	108 33 35.23	Michigan	18,474.42	4.2665708
			310 39 50.42	130 44 37.06	Madeline No. 5	10,959.11	4.0397753
			279 09 39.61	99 22 02.93	Gull	21,815.46	4.3387644
North Twin, 1902 .... d. m..	47 03 34.634	1,069.6	308 19 23.46	128 24 47.61	Outer No. 1	11,932.56	4.0767337
	90 35 19.914	420.3	37 48 33.95	217 42 33.80	Oak No. 2	16,990.70	4.2302113
			101 55 00.67	281 48 53.77	Devils Island light-house ...	10,804.14	4.0335901
			261 39 05.40	....	Outer Island light-house ...	....	....
Outer No. 2, 1901 .... d. m..	47 04 17.313	534.7	55 52 10.07	235.39 39.57	Oak No. 2	26,219.34	4.4186218
	90 26 26.265	554.2	83 22 43.10	263 16 12.40	North Twin	11,337.66	4.0545235
			92 28 32.35	....	Devils Island light-house ...	....	....
Manitou, 1901 .... d. m..	46 57 01.374	42.5	0 26 57.94	180 26 56.26	Hermit No. 2	6,198.15	3.7922624
	90 40 13.494	285.3	72 59 12.33	252 56 47.02	Oak No. 2	4,398.77	3.6433308
Cat, 1902 .... d. m..	46 59 48.434	1,495.7	164 20 33.04	344 19 25.16	North Twin	7,254.80	3.8606255
	90 33 47.136	995.8	273 13 24.88	93 17 41.02	Outer No. 1	7,412.72	3.8699778
South Twin, 1902 .... d. m..	47 01 45.148	1,394.2	228 05 43.30	48 07 54.01	North Twin	5,064.03	3.7044962
	90 38 18.505	390.7	302 08 03.15	122 11 21.66	Cat	6,770.91	3.8306469
Rocky, 1902 .... d. m..	47 02 05.147	158.9	246 18 56.67	66 22 35.43	North Twin	6,887.88	3.8380855
	90 40 18.805	397.0	296 59 50.12	117 04 36.64	Cat	9,287.48	3.9678979
Ironwood, 1902 .... d. m..	47 00 27.724	856.1	126 59 54.43	306 57 36.02	Rocky	5,001.34	3.6990867
	90 37 09.622	203.2	201 51 19.26	21 52 39.54	North Twin	6,219.38	3.7937474
Otter, 1902 .... d. m..	47 00 00.340	10.5	177 48 21.44	357 48 16.32	Rocky	3,856.90	3.5862384
	90 40 11.812	249.6	257 35 23.91	77 37 37.16	Ironwood	3,940.69	3.5955728
Devils, 1902 .... d. m..	47 03 45.743	1,412.6	271 49 42.30	91 55 45.08	North Twin	10,463.34	4.0196702
	90 43 35.465	748.4	359 43 36.44	179 43 38.71	Oak No. 2	13,775.87	4.1391191
			67 39 28.88	247 30 13.59	Sand Island light-house	17,332.85	4.2388700
Sand No. 1, 1902 .... d. m..	46 59 35.817	1,106.1	243 21 57.34	63 30 52.32	Devils	17,260.94	4.2370645
	90 55 46.624	985.2	291 14 37.11	111 23 33.82	Oak No. 2	16,663.03	4.2217540
Rock, 1902 .... d. m..	46 57 46.261	1,428.6	123 42 10.05	303 39 14.44	Sand No. 1	6,100.93	3.7853959
	90 51 46.419	981.4	223 00 00.84	43 05 59.98	Devils	15,191.18	4.1815915
			258 51 07.10	78 53 40.17	Raspberry Island light-house.	4,511.86	3.6543556
Oak No. 3, 1902 .... d. m..	46 57 47.308	1,460.9	89 50 27.98	269 45 12.21	Rock	9,133.70	3.9606465
	90 44 34.403	727.3	186 24 40.06	6 25 23.17	Devils	11,138.53	4.0468279
Bear, 1902 .... d. m..	47 00 09.269	286.2	337 21 47.65	157 22 50.87	Oak No. 3	4,749.43	3.6766411
	90 46 00.866	18.3	58 52 24.42	238 48 11.77	Rock	8,534.39	3.9311724
			90 23 30.15	270 16 01.47	Sand Island light-house	12,960.26	4.1126136

TABLE II.—*Positions, azimuths, and lengths, United States standard datum, secondary triangulation, Apostle Islands*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To stations.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Raspberry, 1902 d. m.	46 58 42.132	1,301.1	206 07 01.78	26 07 47.45	Bear	2,996.99	3.4766858
	90 47 03.314	70.0	298 15 26.92	118 17 15.78	Oak No. 3	3,574.21	3.5531799
York, 1902 d. m.	46 58 58.488	1,806.2	103 31 19.33	283 28 33.18	Sand No. 1	4,938.30	3.6935771
	90 51 59.392	1,255.2	352 59 22.49	172 59 31.97	Rock	2,247.21	3.3516441
Sand No. 2, 1902 d. m.	46 57 54.684	1,688.7	272 50 17.84	92 53 17.64	Rock	5,207.20	3.7166044
	90 55 52.414	1,108.0	248 10 26.13	68 13 16.48	York	5,304.98	3.7246834
			182 14 35.83	2 14 40.06	Sand No. 1	3,125.44	3.4949107
			266 19 34.66	....	Raspberry Island light-house.	....	....
Sand River, 1902 d. m.	46 56 34.021	1,050.6	141 40 36.09	321 39 28.02	Sand No. 2	3,175.46	3.5018071
	90 54 19.273	407.5	213 31 34.95	33 33 17.19	York	5,352.41	3.7285496
Detour (primary), 1870–1902 d. m.	46 56 36.988	1,142.2	230 09 59.02	50 11 38.48	Sand No. 2	3,746.70	3.5736493
	90 58 08.506	179.9	271 03 33.16	91 06 20.66	Sand River	4,849.07	3.6856588
Sand No. 3, 1902 d. m.	46 57 44.446	1,372.5	295 30 04.44	115 32 41.85	Sand River	5,047.24	3.7030540
	90 57 54.665	1,155.9	7 59 56.10	187 59 45.99	Detour	2,103.58	3.3229594
Eagle, 1902 d. m.	46 56 45.806	1,414.5	251 09 27.29	71 12 30.95	Sand No. 3	5,614.17	3.7492858
	91 02 05.979	126.4	273 04 45.47	93 07 38.98	Detour	5,029.71	3.7015426

TABLE III.—*Tertiary points located from the secondary system.*

Station.	Latitude.	Seconds in meters.	Longitude.	Seconds in meters.	Remarks.
	° ′ ″		° ′ ″		
Beaser avenue school	46 34 53.554	1,653.7	90 53 37.954	808.1	Flagstaff on belfry; large yellow brick schoolhouse at Thirteenth avenue west and West Sixth street, Ashland, Wis.
Post-office	46 35 20.361	628.7	90 53 22.243	473.6	Vane on cupola of Government building, Ashland, Wis.
Catholic church spire	46 35 36.410	1,124.3	90 52 56.007	1,192.3	Base of gilt cross on top of spire; tallest spire in Ashland, at Front street and Second avenue east.
Nash schoolhouse	46 36 06.647	205.3	90 57 19.242	409.6	Flagstaff on belfry, Nash, Wis.
Garfield School	46 40 15.587	481.3	90 54 21.346	453.8	Flagstaff on red brick school; Eighth avenue west and Bayfield street, Washburn, Wis.
Walker High School	46 40 43.401	1,340.2	90 53 43.215	918.5	Center of tower over main entrance, Washington avenue, Washburn, Wis.
Court-house	46 40 37.748	1,165.6	90 53 32.744	696.0	Center of dome, Bayfield County, Washburn, Wis.
La Pointe light-house	46 43 43.694	1,349.2	90 47 05.690	120.8	Center of tower, north side of Long Island.
Chequamegon Point light-house	46 43 42.984	1,327.3	90 48 33.344	708.0	Center of tower, west end of Long Island.
La Pointe schoolhouse	46 46 53.906	1,664.6	90 47 25.341	537.6	Flagstaff on belfry, La Pointe, Wis., Madeline Island.
Power house stack	46 48 33.039	1,020.3	90 48 53.671	1,138.0	Center of iron smoke stack of power house, Bayfield, Wis.
Catholic church spire	46 48 53.018	1,637.2	90 48 51.139	1,084.1	Base of gilt cross on top of spire, Bayfield, Wis.
Michigan Island light-house	46 52 16.572	511.8	90 29 48.243	1,021.7	Center of tower, south side of Michigan Island.
Devils Island light-house	47 04 46.574	1,438.3	90 43 41.020	865.5	Center of tower, north end of Devils Island.
Raspberry Island light-house	46 58 14.457	446.4	90 48 17.007	359.5	Center of tower on top of light keeper's house, southwest end Raspberry Island.
Sand Island light-house	47 00 11.682	360.8	90 56 14.324	302.5	Center of tower, corner of light keeper's house, northeast point of Sand Island.
Outer Island light-house	47 04 36.5	1,127.0	90 24 59.7	1,260.0	Center of tower; north end of Outer Island. Position determined by shore line traverse.

DESCRIPTIONS OF SECONDARY TRIAGULATION STATIONS, RESURVEY OF THE APOSTLE ISLANDS, 1902.

Sand No. 1.—Copper bolt in a block of concrete 6 by 6 by 18 inches and marked "U. S. 1902." The top of concrete block is about flush with the ground. A station 30 feet high was built over this point. The station is on the east side of Sand Island in a deep bay near the north end of the island, 38 feet from the top of bank and about 150 feet south of timber line. It stands among old snags and brush in an old burning.

York.—Copper bolt in a block of concrete 6 by 6 by 18 inches and marked "U. S. 1902." Top of block is about flush with the ground. A tripod standing 3.5 feet above ground marks this point. Station is on the south side of York Island about 12 feet from top of bank and 10 feet above water. It stands among small dead tamaracks and about 500 feet west of live timber and near east end of neck of island.

Sand No. 2.—Copper bolt in the center of a concrete block 6 by 6 by 18 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A station 15 feet high was built over this point. It stands in a cleared field on the southeast corner of the island. It is 98 feet west of top of bank and 192 feet northwest of intersection of top of bank and an east and west fence, and 1,200 feet northeast of dock at fishing station on the south side of island.

North Twin.—Copper bolt set in a concrete block 8 by 8 by 18 inches. Top of block is flush with surface of the ground and is marked "U. S. 1901." A station 30 feet high was built over this point. It stands on top of a narrow ridge on the east side of North Twin Island about 80 feet from south end of ridge, 400 feet from extreme south end of the island, and 25 feet from top of bank. Two trees were marked with a triangular blaze, viz:

To 8-inch balsam, 147° 20′, 14 feet.
To 4-inch balsam, 99° 55′, 11 feet.

Devils.—Copper bolt in a concrete block 8 by 8 by 18 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A station 30 feet high was built over this point. It is about 30 feet from top of high caving bank at the extreme south end of Devils Island, 300 feet east of road leading from the boathouse of United States Light-House Establishment to light-house at north end of island, and just about easterly section of breakwater. Reference trees marked with a triangular blaze stand as follows:

24-inch birch, 203° 20′, 26 feet.
4-inch birch, 305° 20′, 25.5 feet.
12-inch birch, 142° 45′, 60.2 feet.
8-inch balsam, 241° 30′, 12.5 feet.

Raspberry.—Copper bolt in a block of concrete 6 by 6 by 18 inches. Top of block is about flush with surface of ground and is marked "U. S. 1902." Only a board target set over this point. It is 6 feet from top of bank on the most easterly point of Raspberry Island. Reference trees marked with triangular blaze stand as follows:

24-inch balsam, 148° 10′, 15 feet.
15-inch birch, 41° 30′, 45 feet.
12-inch poplar, 337° 00′, 15 feet.

Bear.—Copper bolt in a block of concrete 6 by 6 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A board target was set over this point. It is on the southwest corner of Bear Island, on a narrow shelf about 8 feet below the top of the bank and near the center of a short, steep, red-sand bank. Reference trees marked with a triangular blaze stand as follows:

30-inch white pine, 305°, 30′, 9 feet.
4-inch balsam, 310° 08′, 5 feet.
3-inch balsam, 150° 02′, 30 feet.

Oak No. 3.—Copper bolt in a block of concrete 6 by 6 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A tripod standing 3.5 feet above ground marks this point. It is on the north end of Oak Island, 12 feet back from the top of a high caving bank and near the west end of bank. Reference trees marked with a triangular blaze stand as follows:

13-inch birch, 259° 02′, 15 feet.
8-inch balsam, 301° 07′, 8 feet.
10-inch balsam, 34° 47′, 14 feet.

Sand River.—Copper bolt in a block of concrete 6 by 6 by 16 inches. Top of block is about flush with the ground and is marked "U. S. 1902." A tripod standing

about 3.5 feet above ground marks this point, which is 12 feet back from the top of a steep rocky bank. It is about 10,000 feet, by shore line, east of the mouth of Sand River and 5,000 feet east of small creek in bight of bay. Reference trees marked with a triangular blaze stand as follows:

9-inch birch, 243° 12′, 18 feet.
8-inch spruce, 325° 07′, 15 feet.
12-inch hemlock, 31° 52′, 21 feet.

Rock.—Copper bolt cemented in a large flat sandstone 6 feet from water's edge on the most northerly part of Detour Point. Station is marked "U. S. 1902." It is 100 feet east of a log rollway and 25 feet from foot of bank and about opposite the south end of York Island. No reference trees or rocks were marked. There is an old lumber camp 2,000 feet west on top of bank and another camp 4,000 feet east in the mouth of a large ravine.

Eagle.—Copper bolt in a block of concrete 6 by 6 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A board target was set over this point. It is about 20 feet back of water's edge and 6 feet back of edge of bare rock at the northeasterly point of Eagle Island. Reference trees marked with a triangular blaze stand as follows:

8-inch balsam, 342° 25′, 9 feet.
8-inch balsam, 52° 55′, 5 feet.
24-inch birch, 67° 45′, 10 feet.

Sand No. 3.—Copper bolt in a block of concrete 6 by 6 by 18 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A board target was set over this point. It is 15 feet back from top of a steep caving bank and at the southwest point of Sand Island. Three trees were marked with a triangular blaze, but no bearings taken. They stand as follows:

12-inch balsam, distant 45 feet.
14-inch maple, distant 15 feet.
15-inch leaning balsam, distant 30 feet.

Otter.—Copper bolt set in a block of concrete 5 by 7 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A board target was set over this point. It is 20 feet back from the top of a steep bank on the extreme easterly point of Otter Island, just where the shore turns to the northwest. Reference trees marked with a triangular blaze stand as follows:

12-inch cedar, 157° 46′, 13 feet.
14-inch birch, 86° 03′, 20½ feet.
12-inch birch, 35° 53′, 4½ feet.

Cat.—Copper bolt in a block of concrete 6 by 6 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A tripod standing 3.5 feet above ground was set over this point. It is in the center of the sand point on the south end of Cat Island, about 400 feet north of the extreme end of the point, 200 feet south of bank, and 115 feet from shack. No reference trees were marked, and no reference stones were set.

Ironwood.—Copper bolt in the top of a concrete block 6 by 6 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A tripod standing about 3.5 feet above the ground marks this point. It is 22 feet back from the top of a steep, caving rock and sand bank on the northwesterly side of the island. Reference trees marked with a triangular blaze stand as follows:

14-inch birch, 285° 25′, 27 feet.
18-inch birch, 304° 35′, 63 feet.
18-inch birch, 1° 05′, 17 feet.

Rocky.—Copper bolt in the top of a concrete block 6 by 6 by 14 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A tripod standing 4 feet above ground marks this point. It is on top of a narrow ridge on the east side of Rocky Island midway between the most southerly point and the narrowest part of the neck at the north end. It is 30 feet back from edge of water and 30 feet from edge of swamp back of ridge. The ridge is growing wider and higher. Reference trees marked with a triangular blaze stand as follows:

14-inch birch, 128° 18′, 27 feet.
10-inch cedar, 148° 38′, 41.5 feet.
14-inch birch, 183° 03′, 32 feet.

South Twin.—Copper bolt in a block of concrete 6 by 6 by 16 inches. Top of block is about flush with the surface of the ground and is marked "U. S. 1902." A tripod

standing 4 feet above ground is set over the point. The point is 30 feet from the top of the bank on the most easterly point of the south half of the island and about half a mile north of the south end of South Twin Island. Reference trees marked with a triangular blaze stand as follows:

10-inch mountain ash, 48° 50′, 26.5 feet.
27-inch birch, 108° 55′, 28.4 feet.
27-inch birch, 220° 15′, 13 feet.

Detour (*primary*).—Copper bolt in the top of a block of brown sandstone 8 inches square. Top of block is marked with a "+". A 30-foot station was built over the point. It is about 30 feet back from the top of a bluff rock bank 15 feet high on the end of Sand Point and about due south of the west side of Sand Island. Three reference stones, each marked like the geodetic point, are set 15 feet from station, one due east, one south, and one west. Reference trees marked with a triangular blaze stand as follows:

8-inch balsam, 290° 25′, 50 feet.
6-inch balsam, 331° 38′, 31.2 feet.
6-inch balsam, 25° 49′, 39.6 feet.

Outer No. 1.—Copper bolt in cement post situated on southeast end of Outer Island, on highest knoll, one-fourth mile from end of sand point, 50 feet from water's edge on west side, about midway between extreme point and timber. This point is covered with bunch grass. Reference trees marked with a triangular blaze stand as follows:

10-inch double jack pine, 179° 23′, 78 paces.
30-inch pine, 169° 48′, 78 paces.

Topography.—The shore lines of Eagle, Sand, York, Raspberry, Bear, Devils, Otter, Ironwood, Cat, Rocky, North and South Twin, and Outer islands, and the mainland from Red Cliff Point to Sand Point were meandered with transit and stadia. The courses started and ended on stations of the triangulation system.

The traverse of each line was computed, errors in closure of over 1 in 500 in distance or five minutes in azimuth being corrected by retracing lines in the field. Smaller errors were distributed, and the different transit stations plotted on charts by computed coordinates.

Elevations above lake surface were determined for stadia stakes, and such other points as necessary to locate 10-foot contours.

All clearings and buildings along shore were located.

The length of shore line thus taken was 96 miles. A comparison with the shore line of the original survey indicates that the old work was done with great care and attention to detail. The relative position of Cat Island and portions of the shores of adjacent islands were found to be about 500 feet in error, probably due to triangulation.

Hydrography.—The irregularities of the lake bottom among the northerly islands of the group necessitated a closer investigation than in the territory covered by the previous season's work.

The same methods were pursued on inshore sounding except that the greater part was done with the yawl.

Offshore soundings were taken from the *Search*, locating with transits or sextants. Parallel lines were sounded 2,500 to 3,000 feet apart, except where shoal water was known or suspected to exist. These shoal areas were carefully investigated and developed with an idea of locating the depth contours and ascertaining the minimum depth on each shoal.

An important bowlder shoal of about 20 acres extent, with a minimum depth of 17½ feet below plane of reference of 600 feet for Lake Superior, was discovered and developed N. 25° E. seven-eighth mile from the most northerly point of Oak Island. Other changes worthy of note were found in the resurvey of the Bear and Devils islands shoals, originally surveyed by the Hydrographic Office in 1897.

The Bear Island shoal was found to be about three-eighths mile north by west of the charted position, with a minimum depth of 14 instead of 17 feet below a plane of 601.19. The charted shoal shows two distinct portions separated by deep water where only one shoal exists. This mistake was evidently made through the shoal being duplicated by errors in location or plotting of two sets of soundings.

On the Devils Island shoal a minimum depth of 11 feet, instead of 15 feet, was found.

The hydrography of the season included inshore sounding along the 96 miles of shore line, and offshore sounding between the islands and within a margin of 1 to 2 miles outside. There were 39,345 soundings taken, 15,030 of which were located by transits or sextants covering an area of 308 square miles.

Miscellaneous.—In October, 1902, observations were made with Fauth magnetometer for magnetic declination on Rocky, South Twin, and York islands, with the following results:

Station.	Latitude.	Longitude.	Date.	Observed declination.	Time of elongation.	
					Eastern.	Western.
	° ′ ″	° ′ ″	1902.		*a. m.*	*p. m.*
South Twin	47 02 05	90 39 02	Oct. 4	4° 38.4 E.	7.35	1.50
			Oct. 7	4° 41.1 E.	7.50	12.45
			Mean.	4° 39.7 E.		
Rocky	47 02 22	90 40 14	Oct. 8	4° 46.6 E.	7.00	1.00
			Oct. 9	4° 44.8 E.	7.20	1.10
			Mean.	4° 45.7 E.		
York	46 58 35	90 51 34	Oct. 10	4° 57.1 E.	7.15	1.15
			Oct. 11	4° 58.8 E.	8.25	12.30
			Oct. 14	4° 55.6 E.	8.00	12.40
			Mean.	4° 57.2 E.		

The value of one division of magnet was determined to be 3.96 minutes. The collimation of the telescope was changed between the determinations. The axis of the magnet as last used was determined to be −5.31 divisions, designating divisions as plus to apparent right and minus to apparent left of zero in erect positions, or with figures apparently below the graduations.

A box staff gauge was maintained during the season near the light-house on Raspberry Island. Five readings were taken daily. By a comparison of 110 mean daily readings of the Raspberry gauge with corresponding readings on the Marquette gauge, the elevations of the reference bench marks were determined, as follows:

B. M. 1. Cross cut on west basement window sill, near north end of Raspberry Island light-house and residence. Elevation, + 29.91 feet referred to B. M. 1 at Marquette, or 640.40 feet above mean tide at New York.

B. M. 2. Spike driven in root on west side of balsam tree 60 feet southwest of light-house. Elevation, 638.64 feet above mean tide at New York.

B. M. 3. A cross on summit of large sandstone 5 feet from water's edge and 30 feet north of shore end of dock on Raspberry Island. Elevation, 605.02 feet above mean tide at New York.

Observations were continued during the season to note the varying temperature of the surface water, with results as follows:

Temperature of surface water, Lake Superior.

Date.	Locality.	Temperature.
1902.		° F.
June 2	1 mile east of Whitefish Point	41¾
June 4	4 miles north of Outer Island	38
June 12	One-half mile northeast of Point Detour	48
June 20	Midway between Oak Island and mainland	47½
June 25	.....do	50½
June 30	Midway between Raspberry Island and mainland	54½
July 10	Three-fourths mile northwest of Devils Island	53
July 14	1 mile northwest of York Island	57¼
July 23	Between York and mainland	61
July 23	York Island shoal	60½
July 26	Three-fourths mile west of Sand Island	64½
July 28	One-half mile south of Split rock	43
July 31	1 mile west of Bear Island	64
Aug. 7	1 mile east of South Twin	62
Aug. 9	One-half mile north of Cat Island	62½
Aug. 12	1 mile north of Ironwood Island	59½
Aug. 19	One-half mile west of Rocky Island	58½
Aug. 28	One-half mile north of Cat Island	64
Sept. 6	One-half mile north of Outer Island	[a] 55
Sept. 13	One-half mile north of Outer Island	52¾
Sept. 18	Midway between Cat and Presque Isle	54½
Sept. 24	Midway between Presque Isle and Madeline	53
Oct. 1	1 mile south of Outer Island	53
Oct. 7	1 mile east of Gull Island	52
Oct. 10	5 miles north of Eagle Island	48½
Oct. 15	1 mile southwest of Chequamegon Point light-house	51

[a] After two days northwest wind.

Temperature of surface water, Lake Superior—Continued.

OBSERVATIONS MADE DURING RUN FROM BAYFIELD, WIS., TO SAULT STE. MARIE, MICH.

Date.	Locality.	Temperature.
1902.		° F.
Oct. 15	1 mile south of Chequamegon Point light-house	51
Oct. 15	2 miles southeast of Chebonnicon Bay	50½
Oct. 15	4 miles southeast of Michigan Island light-house	50
Oct. 15	15 miles east of Michigan Island light-house	47¼
Oct. 15	22 miles east of Gull Island shoal	47½
Oct. 15	20 miles northwest of Ontonagon, Mich	48
Oct. 15	15 miles north by west of Ontonagon, Mich	50
Oct. 15	19 miles north-northeast of Ontonagon, Mich	50
Oct. 15	14 miles west-southwest of Portage Canal	49¾
Oct. 16	2 miles east of Portage Entry	50½
Oct. 16	2 miles north of Huron Island	51
Oct. 16	6 miles northwest of Big Bay Point	50½
Oct. 16	5 miles southwest of Big Bay Point	50
Oct. 16	5 miles north of Middle Island	50
Oct. 17	4 miles north of Laughing Fish Point	49½
Oct. 17	7 miles northwest of Grand Island light-house	49½
Oct. 17	13 miles west of Point Au Sable light-house	49
Oct. 17	3 miles north of Point Au Sable light-house	49½
Oct. 17	1 mile north of Grand Marais, Mich	49¼
Oct. 18	14 miles east by north of Grand Marais, Mich	49½
Oct. 18	21 miles west of Whitefish Point	49½
Oct. 18	2 miles north of Whitefish Point	49
Oct. 18	Abreast of south end of Parisian Island	51
Oct. 31	.....do	48½
Nov. 5	.....do	48½
Nov. 8	Opposite Frying Pan Island Detour	46

The party left Bayfield, Wis., on October 15, 1902, upon the completion of the Apostle Island survey, to make an investigation of the area adjacent to the south end of Parisian Island in Whitefish Bay. Vesselmen had reported a shoal in this locality, and an attempt was made to locate it. An area of 5 miles along the chartered sailing course and 1½ miles on either side of it was carefully examined. The only shoal water found was within one-fourth mile of the island. It is thought that the vessels reported to have struck in this vicinity have approached the island during fog or thick weather, to within the dangerous water, as shown on charts. Owing to unusually rough weather this survey was not completed until November 5.

The Lake Survey property in storage in the United States Engineers' warehouse at Sault Ste. Marie was taken aboard the *Search*, which left for Alpena, Mich., on November 7. From Alpena a survey was made abreast of Alcona, Mich., to locate and develop a shoal reported as being about 2¼ miles east of the dock at that point. No apparatus for sweeping was available, but a very thorough examination with sounding line failed to reveal any shoal water. A small isolated shoal (probably the same) was located and developed about 6,000 feet east of the Alcona dock.

On November 19 the party on board the steamer *Search* proceeded to East Tawas, Mich., from which place a survey was made locating the easterly limits of the shoal water lying along the mainland between Point Au Sable and town of Au Sable, Mich.

On November 28 the *Search* proceeded to Detroit, Mich., where it was laid up for the winter. With Assistants Caldwell, Vandeburgh, Roberts, and Sunderland I reported for work in the office.

During the field season the notes of the survey were reduced and plotted as rapidly as possible without delaying the field work. The Apostle Island survey was all plotted on 1:10000 detail charts.

On account of the great amount of rough weather, when field work was impossible, the surveys were practically all reduced and plotted at the end of the field season.

After reporting to the office the plotting was completed and the finished detail charts transmitted to you. These, with the data included in this and my previous report, comprise the results of the field operations of 1901 and 1902.

Very respectfully,

F. G. Ray, *Junior Engineer.*

Maj. W. L. Fisk,
Corps of Engineers, U. S. Army.

REPORT OF MR. A. H. HORTON, JUNIOR ENGINEER.

UNITED STATES LAKE SURVEY OFFICE,
Detroit, Mich., April 29, 1903.

MAJOR: I have the honor to present the following report upon the precise level work performed by me between June 6 and November 15, 1902, along the St. Lawrence River in the vicinity of Ogdensburg, N. Y., Morrisburg and Cornwall, Canada, and along the Erie and Oswego canals between Rensselaer (Greenbush) and Oswego, N. Y.

The party was organized at Waddington, N. Y., between June 6 and 9, and consisted of an observer, recorder, two rodmen, and two umbrella men. I take this opportunity of thanking the members of my party for their faithful and efficient services. The recorder, Mr. Fred Lockwood, especially deserves commendation for the carefulness and diligence with which he performed his duties.

After the party was organized, several practice lines were run and the constants of the instrument determined before starting actual work. Acting under Asst. Engineer F. C. Shenehon's orders, bench marks were established on the Canadian Locks Nos. 27, 23, 18, and 15, and the elevations of the zeros of the gauges at Locks 27, 23, and 18 were determined. This work was completed June 29. On June 30 the party was transferred to Albany, N. Y., and work immediately begun on the Greenbush-Oswego line, which was completed November 15. Between November 15 and 18 the constants of the instrument were again determined, and the party was disbanded and the instrument shipped to Detroit.

The outfit consisted of Buff and Berger precise level No. 2768, United States lake survey precise level rods Nos. 1, 3, and 5, steel pins for turning points, wind and sun umbrellas, and apparatus for testing lengths of the rods.

The constants of the precise level are given in Table No. 5. It is of interest to note that the collar inequality in August, 1898, was 0.0235 millimeters per meter, and in November, 1902, was 0.0268 millimeters per meter, or practically no change after running over 1,000 miles of levels. The value of one 2-millimeter division of the level vial in use until September 25 was 1.95 seconds. On this date the vial was accidentally broken. A new one was obtained, the value of one 2-millimeter division of which was 3.86 seconds, which was used for the remainder of the season.

Precise level rods Nos. 1, 3, and 5 were made by W. & L. E. Gurley, of Troy, N.Y., in 1902, from a design in this office made by Mr. David Molitor. They are graduated in 2-millimeter divisions from the bottom up, and are self-reading. A watch-glass level is attached to each rod for plumbing, and there are attachments on each rod for suspending a plumb-bob to test the adjustment of the watch-glass level. The graduations were tested weekly by means of a steel tape made for that purpose.

All level notes were recorded in pencil in note books 8 by $5\frac{1}{2}$ inches, under a uniform system. Two tabulations of the results were made—a "field tabulation" and a "summary of results." The former contains quantities determined from the field observations and the latter quantities derived from the field tabulation.

The method of observing was as follows: The instrument was set up and leveled. A reading of the three wires of the diaphragm, as seen projected against the front (or rear) rod, was taken, the bubble being held continuously in the center of the tube by means of the micrometer screw. Each reading was estimated to tenths of a millimeter. As soon as possible thereafter the three wires of the diaphragm, as seen projected against the rear (or front) rod, were read, estimating to tenths of a millimeter and keeping the bubble in the center of the tube as before. During all the readings the telescope was kept normal and the striding level direct. The recorder inspected the notes, and if no discrepancies were found the rear rodman was signaled "all right," and he pulled his pin and walked to the front rodman. As soon as the recorder finished inspecting the notes, the observer took the striding level from the instrument and walked to the front rod. From there he paced the distance which, in his judgment, was as long a sight as could be taken under the existing conditions, and made a mark on the ground with his foot, at which place the instrument was set up. The rodman who had pulled his pin started pacing from what was then the rear rod and paced to the mark made by the observer, proceeding the same number of paces beyond the mark and driving his pin. As soon as the recorder finished his notes he carried the instrument to the next set-up. During observations and between set-ups the instrument was protected by the sun umbrella, and the striding level was carried in the observer's shadow to shield it from the sun.

It will be noted that the observer determined the length of each sight and that each rodman was responsible for so setting his pin that the foresights and backsights were equal. At each alternate set-up the foresight was read before the backsight. The maximum difference in length between a foresight and backsight was restricted

to 5 meters. The recorder kept a continuous sum of the rod intervals subtended by the extreme wires of the diaphragm on the backsights and foresights, respectively, the two sums being kept as nearly alike as possible and not allowed to differ by more than 10 meters. At the end of a stretch the sums were made nearly equal by so placing the instrument on the last set-up as to eliminate the difference.

The maximum length of sight allowed was 100 meters. The allowable error of closure was 3 millimeters $\sqrt{k}$, where "k" is the distance between bench marks in kilometers. As a rule the direct and reverse lines of a stretch were run during the same half of the day.

The collimation error was determined once each day; the adjustment of the striding level tested at least twice a day; the inequality of the collars determined at the beginning and end of the season; the adjustment of the rod levels tested twice a day; and the graduations of the rods tested weekly. Observations made at different times indicated that there was no wear on the bottom of the rods that could be measured.

The rods were tested in a place sheltered from the sun and wind, in the manner following: Two screw hooks were placed in permanent posts, or other objects, separated by a distance somewhat greater than the length of the rod. One end of a steel tape was fastened to one of the screw hooks and the other end to the snap hook of a spring balance. A cord was run through the handle of the balance and over the other screw hook and its ends tied. This cord was then tightened by a stick placed between its two strands and twisted until the balance indicated a tension of exactly 15 pounds, at which point it was maintained. The rod to be tested was firmly supported near each end and the tape so placed as to be firmly in contact with the face of the rod, the 1-decimeter division of the rod being made to coincide with the same mark of the tape, and carefully watched during observations to see that it so remained. The graduated edge of the tape was placed about 2 millimeters from the center line of the graduation of the rod. Two thermometers were placed at the one-fourth and three-fourth points of the rod, in contact with the tape. The actual tape readings at the decimeter divisions of the rod were recorded, and after each tape reading the temperature was taken by an observer stationed near each thermometer. The tape was read to tenths of a millimeter with the aid of a reading glass.

In the office reduction of the rod tests the true tape reading for each decimeter of the rod was determined, the tape being standard at 15° C. and the temperature of the tape being taken as the mean of the two thermometer readings taken after each decimeter reading. The difference between the true tape reading and the corresponding decimeter reading of the rod gave the correction to the rod at that particular decimeter. The corrections of each rod by the different tests were plotted, using different colored inks for the different tests. The results showed that the rods gradually increased in length in proportion to the length of time they were used. On plate No. 1 are plotted the monthly means of the tests of rod No. 1.

A mean curve for each test was obtained by means of a thread, and a reading was taken where it struck the ordinate of the 30th decimeter. This reading was taken as the correction for 2.9 meters. It was corrected for temperature of the rod, the rods being standard at −3° C., the coefficient of expansion being 0.000004 per degree centigrade. The remaining quantity divided by 2.9 gave the correction per meter to the rod for that particular date. Plate No. 2 shows the results of 23 tests of rod No. 1.

The corrections for all three rods were very nearly the same, so that in deriving a correction that could be applied to the difference of elevation between two consecutive bench marks, the mean correction at the different dates, of the two rods in use, was obtained and plotted, using the dates as abscissas and the corrections as ordinates, similar to plate No. 2. In obtaining the correction to be applied to the difference of elevation between consecutive bench marks, the corrections per meter at the date on which the line was run was found from the curve of corrections. This quantity, multiplied by the difference of elevation in meters gave the correction to the difference of elevation, it being increased by the amount of the correction.

In reducing the level notes, advantage was taken of the fact that the sum of the wire readings divided by three equals the sum of the mean readings; hence the notes were easily checked. The error per meter of excess of foresights over backsights due to collar inequality and to the collimation error was found and applied to the difference of elevation of each stretch, and the correction due to length of the rods was applied. The mean of the corrected difference of elevation by the direct and reverse lines gave the correct difference of elevation between the two bench marks.

Three short lines were run at places along the St. Lawrence River during June, 1902, which connected the zeros of the gauges at locks 27, 23, and 15 of the Canadian canal system with precise level bench marks established on the American side by the U. S. Board of Engineers on Deep Waterways in 1898. These gauges are read daily

at noon by the lock tender, and indicate the depth of water over the sills of the old locks. Permanent bench marks were also established on the locks near the gauges. The elevations of the zeros of the gauges are given in Table No. 7. The elevations are from the 1903 adjustment of lake-survey levels.

The first line was run from P. B. M. No. 10, below Waddington, N. Y., to the St. Lawrence River opposite Morrisburg, Canada. Elevations were transferred across the river by means of water levels, and bench marks were established on the lock. The total length of this line is 3.2 kilometers, including the river crossing. The river is 460 meters wide at this point, with a very swift current and eddies on each side. Gauges were established on both sides of the river and readings taken simultaneously at five-minute intervals for six hours. The weather conditions were good. On account of the swift current, the water-level transfer is a weak part of the line.

The second line was run from P. B. M. "A" at Ogdensburg, N. Y., to the water surface of the St. Lawrence River near the automatic gauge. A water-level transfer was made to the Canadian side and the line continued down the river to the Galops locks. This line is 14.8 kilometers long, including the river crossing. The river is 1,646 meters wide at this point, with a slow current. A gauge was established on the Canadian side, which was read at five-minute intervals for six hours, and simultaneous readings were scaled from the record of the automatic gauge on the American side. This water-level transfer is probably as accurate as a precise level line of the same length.

The third line was run from P. B. M. No. 1, at the mouth of the Raquette River, across the St. Lawrence River by means of the New York and Ottawa Railroad bridge to the lowest of the Cornwall locks. This line is 11.8 kilometers long, and there are no water levels in it. Considerable trouble and annoyance were caused by high winds while attempting to run levels across the bridge, making the bridge vibrate so that it was difficult to obtain accurate readings.

There are five lines of levels between Greenbush and Oswego with a range of 1.7 feet in the results. By omitting one line the range becomes 0.4 foot. The first two lines were run under the direction of the United States Lake Survey in 1875 by two independent parties with ordinary wye levels. One party started from the Greenbush bench mark May 13 and finished August 15. The second party started from the same bench May 28 and finished October 16, using the same bench marks as the first. When the difference between the two results for the difference of elevation between two consecutive bench marks exceeded 0.1 foot $\sqrt{\text{distance in miles}}$, the stretch was releveled to ascertain which was correct. At Oswego the two lines were 1.32 feet apart.

The third line was run by the U. S. Board of Engineers on Deep Waterways in 1897 and 1898 with ordinary wye levels, running direct and reverse lines between benches.

The fourth line was run under the direction of the New York State engineer and surveyor in 1900 and 1901. This line was run by several different parties running duplicate lines with ordinary wye levels.

The fifth line was run by me in 1902. It was commenced July 1 and finished November 15. The route followed the Erie Canal from Albany to Higginsville. From there it went northwesterly along the north side of Lake Oneida, striking the Oswego Canal at Fulton and following the canal to Oswego. All the other lines followed this route with the exception of the New York State survey line, which followed the Erie Canal to Syracuse, and from there ran north along the Oswego Canal to Oswego.

About 400 bench marks have been established between Greenbush and Oswego by the different level lines. The 1902 levels were connected with 20 of the United States Lake Survey bench marks of 1875, 28 of the United States Deep Waterway bench marks, and 93 of the New York State survey bench marks. Forty new bench marks were established, the most of which are between Higginsville and Fulton.

Tables 1 to 4 contain data relating to the Greenbush-Oswego line as run in 1902.

The United States Coast and Geodetic Survey connected the Greenbush bench mark with mean sea level at Sandy Hook, in the spring of 1902, by a new precise level line from Dobbs Ferry to Greenbush. The 1902 precise levels between Greenbush and Oswego give a new value for the difference of elevation between these two points. With this and considerable more new data, the Coast and Geodetic Survey has made a new adjustment of the precise levels of the United States east of the Mississippi River.

The descriptions and elevations of permanent and temporary bench marks established and connected with by the United States Lake Survey will be found in the report of Principal Asst. Engineer E. E. Haskell. The elevations are above mean sea level at Sandy Hook.

Table No. 6 gives the various values that have been determined at different times for the elevation of the Greenbush bench mark.

Very respectfully, your obedient servant,

A. H. HORTON,
Junior Engineer.

Maj. W. L. FISK,
Corps of Engineers, U. S. Army.

PRECISE LEVELS, GREENBUSH TO OSWEGO.

TABLE 1.—*Data in regard to length of line.*

Item.		
1. Length of line	kilometers..	313.265
2. Number of stretches		306
3. Average length of a stretch	meters..	1,024
4. Number of instrument settings		7,628
5. Average number of instrument settings per kilometer		12.2
6. Average length of sight	meters..	41
7. Length of line run two times	kilometers..	294.873
8. Length of line run three times	do....	7.445
9. Length of line run four times	do....	10.947
10. Total single line	do....	663.314
11. Number of permanent bench marks established or connected with		143
12. Number of temporary bench marks		246
13. Probable error at end of line	millimeters..	±6.84
14. Probable error per kilometer	do....	± .39
15. Actual closure at end of line	do....	12.3
16. Residuals passed through zero	times..	4
17. Maximum value of residual	millimeters..	17.45

TABLE 2.—*Data in regard to rapidity of work.*

Item.	
1. Total number of days in field	138
2. Number of Sundays (19) and holidays (3)	22
3. Number of days lost by rain, repairing instrument, and moving	13
4. Number of working days (1–2)	116
5. Number of days actually worked (4–3)	103
6. Number of hours actually worked	842
7. Number of kilometers of single line run	663.314
8. Number of kilometers of single line run per day in field	4.80
9. Number of kilometers of single line run per working day	5.72
10. Number of kilometers of single line run per day actually worked	6.44
11. Number of kilometers of single line run per hour actually worked	.787
12. Average time consumed per setting, in minutes	5.4

TABLE 3.—*Accuracy.*

Item.	
1. Number of closures between 0.0–0.5 mm	105
2. Number of closures between 0.5–1.0 mm	81
3. Number of closures between 1.0–1.5 mm	54
4. Number of closures between 1.5–2.0 mm	44
5. Number of closures between 2.0–2.5 mm	16
6. Number of closures between 2.5–3.0 mm	6
7. Total number of stretches (see item 2, Table 1)	306
8. Number of stretches that did not close on the first trial	16
Percentage of total number of stretches	5
9. Number of stretches that did not close due to errors of recording and rodding	6
Percentage of total number of stretches	2
10. Number of stretches that did not close due to errors of "observing"	10
Percentage of total number of stretches	3

TABLE 4.—*Cost.*

Item.	
1. Salaries	$2,250.00
[a]2. Traveling expenses in field, livery, repairs, etc	204.00
3. Total cost of leveling 663.314 kilometers of single line	2,454.00
4. Cost per single kilometer	3.70
5. Cost per mile of completed line	11.84

[a] Item 2 does not include traveling expenses to or from the field.

TABLE 5.—*Constants of precise level No. 2768.*

Magnifying power, in diameters		50
Focal length of objective	millimeters	402
Diameter of objective	do	38
Ratio of telemeter threads to distance		1:200
Curvature of level tube, in seconds, per 2 millimeters:		
From June 1 until September 30, 1902		1.95
From September 30 to November 15, 1902		3.86
Inequality of collars	millimeters per meter	.0269
Weight of instrument	kilograms	5.3
Weight of tripod	do	7.6
Smallest graduation on rods	millimeters	2

TABLE 6.—*Elevations of Greenbush bench.*

Date.	Authority.	Elevation.
		Feet.
1857-58	Mr. J. B. Vose, U. S. Coast and Geodetic Survey	15.37
1877	Mr. O. H. Tittmann, U. S. Coast and Geodetic Survey	14.728
1889	Deduced from West Shore R. R. levels	16.01
1894	Coast and Geodetic Survey (mean of the two following lines)	13.64
1893-1895	Topographical Survey Commission of Massachusetts from Boston	14.07
1893-1895	Topographical Survey Commission of Massachusetts from Dobbs Ferry	13.22
1898-99	U. S. Coast and Geodetic Survey, Appendix No. 8, p. 540	13.577
1903	U. S. Coast and Geodetic Survey	13.863

TABLE 7.—*Elevations of the zeros of the gauges at Canadian Locks Nos. 27, 23, and 15 on the St. Lawrence River.*

Lock No.	Locality.	Elevation of zero of gauge above mean tide at New York by 1903 adjustment.	
		Meters.	*Feet.*
27	Galops Rapids, Canada	71.3671	234.144
23	Morrisburg, Canada	[a] 63.3293	207.773
		[b] 61.4830	201.715
15	Cornwall, Canada	43.7222	143.445

[a] Old lock. [b] New lock.

REPORT OF MR. THOMAS RUSSELL, ASSISTANT ENGINEER.

UNITED STATES LAKE SURVEY OFFICE,
Detroit, Mich., June 30, 1903.

MAJOR: I have the honor to make the following report on reduction of Detroit River triangulation and its adaptation to the United States standard datum of the Coast and Geodetic Survey, with tables of positions, azimuths, and distances conformable with those given in Report of Chief of Engineers for 1902, page 2905, and on the adjustment of the St. Clair River triangulation of 1899 to 1902 and its adaptation to the United States standard datum of the Coast and Geodetic Survey.

DETROIT RIVER.

From Wyandotte to Point Mouillée the system is mostly quadrilaterals. The angles were measured by Mr. Hermann Kallman, inspector, and the adjustments, locally and for angle and side equations, made by Mr. David Molitor, assistant engineer, in 1894. From Wyandotte north to the line 27–28 the angles were measured by Asst. Engineer Charles Y. Dixon in 1899, and from 27–28 to Windmill Point Light-house on Lake St. Clair in 1901 by Mr. Murray Blanchard, junior engineer.

The stations Sugar Island, Bois Blanc, Turkey Island, and Fighting Island are the same points in this system as those of the same name in the old system of triangulation measured in 1873. Other stations of the same name in the two systems are not the same points.

The system from Wyandotte north to Lake St. Clair, while composed mainly of quadrilaterals, is only adjusted for the closing of triangles.

The triangle sides were computed, starting with the standard line Tur[illegible] Fighting Island, the length of which—given in report for 1902, page 2935—is [illegible]3.02 meters, logarithm 3.8097632. The length of line Sugar Island-Bois Blanc, computed from this through the intervening triangles, is logarithm 3.313885. The standard length of line given in report for 1902 is 3.313886, a difference of 1/400000.

The length of Fort Wayne base line, 50 N. E. Base to New S. W. Base, computed from the line Turkey Island-Fighting Island, through 16 triangles, is logarithm 2.84034; the measured length is 2.84026, or about 1/5000 less.

The angles in this stretch were adjusted by a side equation to make the computed length of base line agree with the measured length. The greatest correction to any angle was 3 seconds.

The length of line 99 Peach to Windmill Point light-house, 1875, computed from Fort Wayne base line, through 29 triangles, was logarithm 3.13940; the length derived from a triangulation by David Molitor in 1897 in vicinity of Lake St. Clair was logarithm 3.13929, or about 1/4000 less. No adjustment of the angles was made for this difference, however.

In the loop of triangulation around Belle Isle the length of line 93 Traub—106 Island light, computed by north side of island, is logarithm 3.03468 and by the south side 3.03466. An adjustment was made to make the side by the two routes agree.

Starting with the standard positions and azimuths of Turkey Island and Fighting Island given in report for 1902 the position of Sugar Island was found to be:

	42° 05′ 25.214″	83° 08′ 34.519″
azimuth to Bois Blanc	228° 24′ 07.4″	

The standard position of Sugar Island given in report for 1902 is:

	42° 05′ 25.208″	83° 08′ 34.537″
azimuth to Bois Blanc	228° 24′ 17.3″	

The discrepancies of 0.006″ in latitude, 0.018″ in longitude, and 9.9″ in azimuth were distributed uniformly over the seven intervening triangles.

With the standard position of Sugar Island and azimuth to Bois Blanc the positions of the remaining stations to the mouth of river through five triangles to Pointe Mouillée were computed. The position of Detroit River light-house is determined by differences from Detroit River light-house station, which it is near, as given in report No. 63 of November 27, 1894. The positions given for range lights at head of Bois Blanc Island are obtained from the same report in the same way.

From the standard positions of Turkey Island and Wyandotte the position computation was continued north to Windmill Point light-house, on Lake St. Clair. The agreement in position of Windmill Point light-house, as given by this triangulation and the system measured in 1873, is a good check on the measurement of the intervening angles and correctness of the reduction.

Windmill Point light-house was rebuilt in 1875. The coordinates of old position of light from new position were furnished by engineer of Light-House Department.

The position derived for old Windmill Point light-house was:

42° 21′ 29.956″ 82° 55′ 48.795″

The position of the same point given by the triangulation of 1873 was:

42° 21′ 29.950″ 82° 55′ 48.851″

The latitudes and longitudes were adjusted by distributing the discrepancies of 0.006″ in latitude and 0.056″ in longitude uniformly over the intervening forty-three triangles from Turkey Island to Windmill Point Light-house.

No direct comparison of an azimuth could be made at the Lake St. Clair end of triangulation with an azimuth of the triangulation of 1873, but an indirect comparison is possible by means of the positions.

The unadjusted position of the Detroit City Hall Flagstaff by the recent triangulation was:

42° 19′ 52.186″ 83° 02′ 50.687″

This position, with that given by recent triangulation for old Windmill Point Light-house, gives the azimuth of line Detroit City Hall to old Windmill Point Light-house

252° 36′ 26″

The azimuth of same line derived from positions determined by 1873 triangulation given in report for 1902, page 2936, is

252° 36′ 41″

No adjustment was made of this difference of 15″ in azimuth, as the line is not a directly observed one.

The astronomic azimuth of line 99 Peach to new Windmill Point Light-house, as determined by Mr. David Molitor, assistant engineer, is

173° 16′ 01″

The geodetic azimuth of the line, as determined by the recent triangulation, is

173° 15′ 30″

In the loop of triangulation around Belle Isle the position of 93 Traub by the route north of island was 0.003″ greater in latitude, 0.006″ greater in longitude, and the azimuth of line 93 Traub to 106 Island Light 9.5″ less than the position and azimuth derived going south side of island. These differences were uniformly distributed in the 16 triangles around the island before distributing the discrepancies between Turkey Island and Windmill Island Light-house stretch.

In the table of positions, Table 1, the year when first occupied is given below the name of station. The letters d and m after a station indicate described and marked.

Descriptions of stations from 27 to Windmill Point are given in report for 1902, page 2857.

ST. CLAIR RIVER.

The positions, azimuths, and lengths of lines given in Table 2 are on the United States Standard Datum of the Coast and Geodetic Survey, conformable with those given in Report of Chief of Engineers for 1902, page 2905.

The stretch of triangulation, which is composed mainly of quadrilaterals, extends from the station Huron Point and St. Clair Flats Rear Range Light-house of the old triangulation of Lake St. Clair of 1871 to stations Pine and Sand on Lake Huron.

The observed angles were locally corrected, and the triangles and quadrilaterals of each figure adjusted separately to satisfy the angle and side equations.

There are five base lines in the triangulation accurately measured with steel tapes: Maple Leaf (175 to 177), Belle River (137 to 139), Idlewild (101 to 103), D and C Base Port Huron and Park Base Port Huron.

The line Huron Point to St. Clair Rear Range Light-house was not directly observed in the 1871 triangulation. The length of the line is derived from the triangle these two points make with station North Channel, two sides being known and the angle at North Channel being obtained from the difference of azimuths to Huron Point and St. Clair Flats Rear Range Light-house. The length of this line depends on a base line measured in 1872 on railroad track on south shore of Lake St. Clair near entrance to Detroit River. There are 9 triangles between this line and the Lake St. Clair Base Line.

The Maple Leaf Base Line as computed from the side Huron Point-St. Clair Flats Rear Range Light-house through 12 triangles was 2.822781, logarithms in meters, as compared with 2.822834 the measured length, a difference of the 1/8800 part.

The length of Belle River Base computed from Maple Leaf Base through 35 triangles was 2.961034, logarithms in meters, as compared with 2.960983 the measured length, a difference of the 1/8200 part.

The length of Idlewild Base computed from Belle River Base through 34 triangles was 2.762684, logarithms in meters, as compared with 2.762760 the measured length, a difference of the 1/5660 part.

The length of the D and C Base Port Huron computed from the Idlewild Base through 27 triangles was 2.823194, logarithms in meters, as compared with 2.823235 the measured length, a difference of the 1/10400 part.

The length of Park Base Port Huron, computed from the D and C Base Port Huron, through 8 triangles was 2.827663, logarithms in meters, as compared with 2.827769 the measured length, a difference of the 1/4000 part.

Beyond Park Base Port Huron, there are 9 triangles to the line Pine-Sand.

The angles in the triangles over these various stretches of triangulation were adjusted by introducing a side equation in each to make the computed lengths agree with the measured lengths.

The positions of the points were computed starting with the standard positions of Huron Point and St. Clair Flats Rear Range Light-house, given in report for 1902, page 2938, and an azimuth for the line derived from the standard azimuth Huron Point to North Channel.

The astronomic azimuth observed on the line 167 to 165, 21 triangles from Huron Point was 218° 53′ 55″. The geodetic azimuth derived from Huron Point is 218° 53′ 47.4″.

The astronomic azimuth observed on line 115 to 113, 70 triangles from Huron Point, was 200° 05′ 00″. The geodetic azimuth derived from Huron Point is 200° 04′ 04.3″. The observed azimuth is considered to be about one minute in error.

The astronomic azimuth observed on Idlewild Base, 80 triangles from Huron Point, was 175° 39′ 36″. The geodetic azimuth derived from Huron Point is 175° 39′ 42.1″.

The astronomic azimuth observed on the D and C Base Port Huron, 107 triangles from Huron Point, was 13° 14′ 27″. The geodetic azimuth derived from Huron Point is 13° 14′ 08.6″. The observed azimuth here was the best and most carefully observed in the chain of triangulation and is relied upon as showing the accuracy of angles in the intervening triangles and the correctness of the computation.

The position of station Lumber is doubtful. The location adopted is that given by angles at North Base and South Base, which does not agree with angle at Oil. Lumber is an isolated station and does not affect the triangulation beyond it.

The azimuths in table are geodetic azimuths derived from Huron Point, no modifications being introduced on account of any of the observed azimuths.

The position of Fort Gratiot Light-house, determined geodetically by this triangulation, is also known astronomically. From the Report of the Chief of Topographical Engineers for 1860, page 48, the astronomic difference of longitude from Detroit Observatory, 1857–1870, to Fort Gratiot Light-house is found to be —37′ 49.74″. The astronomic longitude of Detroit Observatory, 1871, on the Coast and Geodetic Survey Astronomic Datum is 83° 03′ 02.94″, report for 1902, page 2901. Detroit Observatory, 1871, to Detroit Observatory, 1857–1870, is —1.91″, report of 1902, page 2936. The astronomic position of Fort Gratiot Light-house is then:

43° 00′ 21.86″ 82° 25′ 11.29″.

The geodetic position of Fort Gratiot Light-house from the triangulation is:

43° 00′ 22.44″ 82° 25′ 20.81″.

The differences are in latitude A—G=—0.58″ and in longitude A—G=—9.52″.

The astronomic difference of longitude between Detroit, 1857–1870, and Fort Gratiot Light-house was determined by chronometer expeditions, the result depending on nine round trips between the stations with seven chronometers.

In this report are also given in Table 4 the results of discharge measurements of St. Clair River made by Mr. Murray Blanchard, junior engineer, in August and September, 1902. The observations were made on the dry dock cross section 4.9 miles from Lake Huron. Two meters were used, 14 B at 0.5 depth twice and 8 B at the 0.3 and 0.7 depths. The velocities were observed at the centers of twenty-one sections. The stations were 100 feet apart. Section No. 1 on Michigan side is 115 feet wide for a gauge reading of 578 and 120 feet for 579. Section No. 21 at the other side is 107 feet wide at 578 and 112 feet at 579.

The observations for discharge were made in the same way as in 1899, 1900, and 1901. The method is described in report for 1900, pages 5362 to 5401.

A redetermination of the cross section was made. The very small differences in the depths on the section, as compared with those of preceding measurements, are considered to be due entirely to the unavoidable errors of observation. The means of the recent and former measurements were used in deriving the cross section adopted in the reduction.

Some observations were made at tenths of depth for vertical distribution of velocity. The new values of factors derived to reduce velocities at different depths to mean of depths agreed so closely with the old values that the old values were retained in this reduction.

The velocities depend on ratings of meters made in August, 1902.

For 14 B the equation is:

$$y=1.208x+0.096$$

For 8 B the equation is:

$$y=1.269x+0.065$$

In the equations y is the velocity in feet per second; x is the number of turns of wheel per second.

In the table of results the discharges are given in units of 100 cubic feet per second. Two are given for 0.5 depth and one for 0.3 and one for 0.7 depth, and also the mean of the four.

The gauge readings in table corresponding to discharge measurements are the weighted means of the readings taken at the time of the velocity measurement at each station. The weight was taken proportional to the quantity of water passing in the section. The elevations are based on a height of 589.90 for height of Fort Gratiot Light-house bench mark.

The mean of the two results given by 14 B is smaller than the mean of the two results given by 8 B in the first part of the work from August 12 to September 10. In the latter part of the work the results by 14 B are larger. In the mean of the 48 measurements 8 B gives a larger result by 1,070 cubic feet than 14 B. Comparing the means of four with each individual result the residuals give the probable error of a single result ±1,570 cubic feet.

In Table 3 are given the areas of the various sections of the cross section for a height of 578 on the dry dock section gauge. The table contains also the factors by which the velocities at 0.3, 0.5, and 0.7 depths are to be multiplied to give the mean velocity throughout the depth.

Very respectfully, your obedient servant,

THOMAS RUSSELL,
Assistant Engineer.

Maj. W. L. FISK,
Corps of Engineers, U. S. Army.

TABLE 1.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, Detroit River.*

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
Detroit River Light-house, 1894	42 00 02.82	87.0					
	83 08 28.29	651.1					
Detroit River Light-house Station, 1894	42 00 03.295	101.7					
	83 08 28.154	648.0					
Pointe Mouillée, 1894	42 00 49.657	1,532.1	293 04 12.8	113 05 50.4	Detroit River Light-house Station.	3,648.27	3.562087
	83 10 53.997	1,242.5					
Bar Point, 1894	42 03 17.724	546.9	18 58 16.5	198 57 16.5	Detroit River Light-house Station.	6,343.05	3.802298
	83 06 58.554	1,346.4	49 52 22.5	229 49 44.8	Pointe Mouillée, 1894	7,085.23	3.850354
Clay Bank, 1894	42 02 53.028	1,636.1	262 28 11.1	82 30 59.5	Bar Point, 1894	5,832.36	3.765844
	83 11 10.003	230.0	354 28 25.0	174 28 35.7	Pointe Mouillée, 1894	3,824.20	3.582541
			324 34 17.1	144 36 05.5	Detroit River Light-house Station.	6,425.64	3.807916
Sugar Island, 1873–1894 d. m.	42 05 25.208	777.8	330 42 00.1	150 43 04.4	Bar Point, 1894	4,510.01	3.654177
	83 08 34.537	793.7	37 17 35.4	217 15 51.2	Clay Bank	5,900.91	3.770919
Hackett, 1894	42 05 16.091	496.5	353 19 40.8	173 19 53.2	Bar Point, 1894	3,676.98	3.565491
	83 07 17.133	393.8	98 59 33.1	278 58 41.2	Sugar Island	1,801.05	3.255526
			50 31 00.4	230 28 24.4	Clay Bank	6,938.76	3.841282
Bois Blanc, 1873–1894 d. m.	42 06 09.529	294.0	351 47 11.6	171 47 18.5	Hackett, 1894	1,665.82	3.221629
	83 07 27.448	631.6	48 25 02.2	228 24 17.3	Sugar Island	2,060.09	3.3138858
Stony, 1894	42 07 32.946	1,016.5	352 50 56.4	172 51 05.8	Bois Blanc	2,593.84	3.413943
	83 07 41.543	954.2	17 10 27.1	197 09 51.5	Sugar Island	4,124.93	3.615417
Clark, 1894	42 08 19.542	602.9	10 05 08.6	190 04 47.8	Bois Blanc	4,074.20	3.610042
	83 06 56.439	1,296.1	35 46 44.6	215 46 14.3	Stony	1,771.92	3.248450
			22 44 34.1	202 43 29.9	Sugar Island	5,831.81	3.765803
Broadhead, 1894	42 09 34.190	1,054.9	321 37 23.3	141 38 16.6	Clark	2,937.70	3.468007
	83 08 15.858	364.1	348 06 06.8	168 06 29.8	Stony	3,822.94	3.582398
Turkey Island, 1873–1894 d. m.	42 11 09.173	283.0	1 38 51.2	181 38 46.8	Clark	5,235.90	3.718991
	83 06 49.880	1,144.6	33 57 45.2	213 56 47.4	Broadhead, 1894	3,532.95	3.548138
			10 05 06.7	190 04 32.2	Stony	6,775.95	3.830970

Farnum, 1894	42 10 51.991 83 08 36.365	1,604.1 834.5	257 45 03.8 348 54 13.2 333 59 29.8	77 46 15.3 168 54 27.0 154 00 39.6	Turkey Island Broadhead Clark	2,500.39 2,446.19 5,233.28	3.398007 3.388491 3.718774
Wyandotte, 1894	42 12 38.932 83 08 40.200	1,201.2 922.2	317 33 56.5 358 28 18.3	137 35 10.6 178 28 20.9	Turkey Island Farnum	3,751.79 3,300.72	3.574239 3.518609
Fighting Island, 1873-1894 d. m.	42 14 38.236 83 06 57.692	1,179.7 1,322.6	358 24 29.0 32 34 19.2 17 58 21.9	178 24 34.3 212 33 10.3 197 57 18.5	Turkey Island Wyandotte Farnum	6,453.02 4,367.63 7,338.33	3.8097632 3.640246 3.865597
Ecorse, 1894	42 15 17.131 83 08 06.436	528.6 147.5	307 17 03.6 9 00 59.0 167 04 54.8	127 17 49.8 189 00 36.3 347 04 03.2	Fighting Island Wyandotte Turkey Island	1,980.80 4,942.17 7,849.36	3.296841 3.693918 3.894834
Mamajuda Light-house, 1897	42 11 30.578 83 08 10.096	943.5 231.7	289 43 50.0 26 51 09.0	109 44 44.0 206 50 51.0	Turkey Island Farnum	1,955.58 1,334.38	3.291275 3.125280
Mamajuda Range Front Light, 1897	42 11 36.445 83 08 08.943	1,124.5 205.2	24 38 34.0 159 36 12.0	204 38 16.0 339 35 50.0	Farnum Wyandotte	1,508.94 2,057.01	3.178673 3.313237
Grassy Island Front Range Light, 1899	42 13 13.528 83 07 59.712	417.4 1,369.6	282 05 59.0 41 01 32.0	102 06 20.0 221 01 05.0	21 Wyandotte	708.53 1,414.83	2.850360 3.150705
Grassy Island Light-house, 1899	42 13 27.655 83 07 59.556	853.3 1,365.9	310 17 39.0 31 48 19.0	130 18 00.0 211 47 52.0	21 Wyandotte	903.64 1,768.85	2.955995 3.247692
Grassy Island North Channel, Range Rear Light, 1899	42 13 28.975 83 08 22.025	894.0 505.1	161 03 59.0 250 55 07.0	341 03 46.0 70 55 40.0	22 23	1,372.78 1,202.25	3.137602 3.079996
Grassy Island North Channel, Range Front Light, 1899	42 13 46.627 83 08 09.958	1,438.6 228.3	136 14 07.0 280 00 21.0	316 13 46.0 100 00 45.0	22 23	1,043.91 872.79	3.018664 2.940911
Ecorse Range Front Light, 1899	42 14 47.621 83 07 51.348	1,469.3 1,177.2	296 58 43.0 45 31 30.0	116 59 05.0 225 30 56.0	25 22	857.66 1,610.02	2.933315 3.206830
Ecorse Range Rear Light, 1899	42 14 53.052 83 07 51.671	1,636.9 1,184.6	305 48 12.0 41 22 52.0	125 48 35.0 221 22 19.0	25 22	951.54 1,726.65	2.978429 3.237204
Bois Blanc Light-house, 1897	42 05 12.77 83 07 10.31	394.0 237.0	355 39 19.0 10 37 42.0	175 39 26.0 190 36 49.0	Bar Point, 1894 Detroit River Light-house Station.	3,561.39 9,716.50	3.551616 3.987505
Head of Bois Blanc Island, Rear Range Light, 1894	42 06 12.75 83 07 14.18	393.4 325.8					
Head of Bois Blanc Island, Front Range Light, 1894	42 06 17.06 83 07 11.93	526.4 274.1					
20, 1899	42 11 06.801 83 08 30.983	209.8 711.0	175 44 51.0 268 11 02.0	355 44 45.0 88 12 10.0	Wyandotte Turkey Island	2,850.49 2,321.24	3.454919 3.365720

TABLE 1.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, Detroit River*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
21, 1899	42 13 08.713	268.8	346 09 01.0	166 09 28.0	Turkey Island	3,798.74	3.579637
	83 07 29.506	676.8	60 28 00.0	240 27 12.0	Wyandotte	1,863.72	3.270384
22, 1899	42 14 11.059	341.2	319 22 34.0	139 23 32.0	21	2,534.20	3.403845
	83 08 41.449	950.4	359 25 21.0	179 25 22.0	Wyandotte	2,842.69	3.453730
23, 1899	42 13 41.710	1,287.0	38 43 56.0	218 43 10.0	Wyandotte	2,482.85	3.394950
	83 07 32.479	744.8	119 48 01.0	299 47 15.0	22	1,822.47	3.260662
			356 10 25.0	176 10 27.0	21	1,020.38	3.008763
24, 1899	42 14 47.550	1,467.1	348 02 16.0	168 02 29.0	23	2,076.54	3.317344
	83 07 51.246	1,174.9	45 38 13.0	225 37 39.0	22	1,610.16	3.206869
25, 1899	42 14 35.009	1,080.2	11 24 26.0	191 24 16.0	23	1,677.64	3.224697
	83 07 18.011	412.9	68 53 20.0	248 52 24.0	22	2,050.88	3.311942
26, 1899	42 14 52.973	1,634.4	305 46 01.0	125 46 24.0	25	948.31	2.976949
	83 07 51.574	1,182.3	41 29 24.0	221 28 51.0	22	1,726.35	3.237133
			168 44 31.0	348 44 18.0	23	2,241.98	3.350631
28 Brick, 1899	42 15 38.077	1,174.8	9 33 50.0	189 33 40.0	25	1,973.38	3.295214
	83 07 03.714	85.1	38 15 19.0	218 14 47.0	26	1,772.11	3.248493
27, 1899	42 15 30.708	947.5	38 07 35.0	218 06 56.0	25	2,184.54	3.339360
	83 06 19.188	439.8	102 33 50.0	282 33 20.0	28 Brick	1,045.61	3.019373
62 Smith, 1901 d.m.	42 16 16.302	503.0	341 13 23.0	161 13 37.0	27	1,485.87	3.171982
	83 06 40.055	918.0	24 41 38.0	204 41 22.0	28 Brick	1,298.14	3.113320
57 Boathouse, 1901 d.m.	42 16 22.778	702.8	14 33 30.0	194 33 18.0	27	1,659.89	8.220081
	83 06 00.988	22.6	77 25 19.0	257 24 53.0	62 Smith	917.32	2.962519
			46 11 39.0	226 10 57.0	28 Brick	1,992.46	3.299390
⊙ 59 Chapels, 1901 d.m.	42 15 51.497	1,588.9	141 57 21.0	321 57 03.0	62 Smith	971.81	2.987584
	83 06 13.921	319.1	197 04 17.0	17 04 26.0	57 Boathouse	1,009.62	3.004160
Willow, 1901	42 16 03.065	94.6	118 25 07.0	298 24 45.0	62 Smith	858.24	2.933611
	83 06 07.116	163.0	193 00 18.0	13 00 22.0	57 Boathouse	624.24	2.795351
55 Ruin, 1901 d.m.	42 17 02.116	65.3	22 15 03.0	202 14 48.0	57 Boathouse	1,311.38	3.117730
	83 05 39.321	900.9	44 33 36.0	224 32 55.0	62 Smith	1,983.72	3.297480

58 Solvay, 1901 .... d. m.	42 17 17.688 83 06 10.758	545.8 246.4	303 42 19.0 19 31 16.0 352 28 30.0	123 42 40.0 199 30 56.0 172 28 36.0	55 Ruin 62 Smith 57 Boathouse	865.78 2,009.51 1,708.95	2.937412 3.303094 3.232728
60 Marsh, 1901 .... d. m.	42 17 02.326 83 06 49.708	71.8 1,139.0	242 01 23.0 270 13 30.0 317 32 37.0	62 01 49.0 90 14 17.0 137 33 09.0	58 Solvay 55 Ruin 57 Boathouse	1,010.46 1,612.69 1,653.83	3.00452 3.207552 3.218490
53 Canal, 1901 .... d. m.	42 17 24.601 83 05 27.463	759.0 629.2	21 23 26.0 77 52 08.0	201 23 18.0 257 51 38.0	55 Ruin 58 Solvay	745.09 1,014.59	2.872208 3.006291
New Southwest Base, 1901	42 17 37.967 83 05 55.873	1,171.4 1,280.1	302 21 42.0 28 35 40.0 341 04 52.0	122 22 02.0 208 35 30.0 161 05 04.0	53 Canal 58 Solvay 55 Ruin	770.50 712.66 1,169.39	2.886774 2.852880 3.067956
51 Section, 1901 .... d. m.	42 17 37.005 83 05 16.972	1,141.7 388.8	32 07 58.0 91 54 39.0	212 07 51.0 271 54 12.0	53 Canal New Southwest Base	452.01 891.70	2.655152 2.950216
50 Northeast Base, 1901 .... d. m.	42 17 54.331 83 05 35.202	1,676.3 806.4	322 00 12.0 43 10 05.0 349 04 00.0	142 00 25.0 223 09 52.0 169 04 06.0	51 Section New Southwest Base 53 Canal	678.36 692.25 934.33	2.831456 2.840264 2.970496
54 Old Southwest Base, 1901 .... d. m.	42 17 37.833 83 05 55.680	1,167.3 1,275.7	132 39 34.0 222 39 34.0	312 39 34.0 42 39 47.0	New Southwest Base 50 Northeast Base	6.095 692.21	0.785 2.840244
52 Middle Base, 1901 .... d. m.	42 17 50.672 83 05 39.745	1,563.4 910.5	42 39 44.0	222 39 44.0	54 Old Southwest Base	538.68	2.731333
51 Section Offset, 1901	42 17 37.000 83 05 16.960	1,141.0 388.6	91 40 00.0 128 57 00.0	271 39 34.0 308 56 44.0	54 Old Southwest Base 52 Middle Base	887.40 671.14	2.94812 2.82681
61 Warehouse, 1901 .... d. m.	42 18 10.363 83 04 41.714	319.8 955.5	38 07 39.0 68 01 12.0	218 07 16.0 248 00 36.0	51 Section 50 Northeast Base	1,308.34 1,321.36	3.116722 3.121015
64 Clark, 1901 .... d. m.	42 18 25.975 83 05 06.562	801.4 150.3	310 14 39.0 33 54 08.0 8 58 23.0	130 14 55.0 213 53 48.0 188 58 16.0	61 Warehouse 50 Northeast Base 51 Section	745.61 1,176.33 1,529.68	2.872514 3.070533 3.184600
Sandwich Court-House Tower, 1903	42 18 00.458 83 04 35.273	14.1 808.0	52 51 30.0 137 41 48.0	232 51 02.0 317 41 27.0	51 Section 64 Clark	1,198.37 1,064.61	3.078591 3.027188
63 Pipe, 1901 .... d. m.	42 18 34.617 83 04 22.600	1,068.1 517.6	30 19 54.0 75 10 21.0	210 19 41.0 255 09 52.0	61 Warehouse 64 Clark	867.02 1,041.60	2.938026 3.017696
66 Gas, 1901 .... d. m.	42 18 49.230 83 04 36.415	1,519.0 834.0	324 56 46.0 43 54 08.0 5 46 57.0	144 56 55.0 223 53 48.0 185 46 53.0	63 Pipe 64 Clark 61 Warehouse	550.82 995.82 1,205.40	2.741014 2.998178 3.081131
65 M. C. R, 1901 .... d. m.	42 18 53.094 83 03 36.323	1,638.2 831.9	61 43 41.0 85 03 17.0	241 43 10.0 265 02 37.0	63 Pipe 66 Gas	1,203.51 1,381.37	3.080451 3.140308

TABLE 1.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, Detroit River*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
68 B, 1901 d. m.	42 19 14.729	454.4	331 56 45.0	151 56 55.0	65 M. C. R	756.43	2.878768
	83 03 51.860	1,187.6	29 38 16.0	209 37 55.0	63 Pipe	1,423.97	3.153495
			48 41 01.0	228 40 11.0	64 Clark	2,278.19	3.357590
Fort Street Presbyterian Church, Detroit, 1901	42 19 39.145	1,207.8	351 43 36.0	171 43 41.0	67 C. P. R	1,164.77	3.06624
	83 03 14.658	335.7	48 30 51.0	228 30 26.0	68 B	1,137.21	3.05584
67 C. P. R, 1901 d. m.	42 19 01.788	55.2	67 59 48.0	247 59 28.0	65 M. C. R	716.00	2.854913
	83 03 07.739	168.1	111 23 26.0	291 22 56.0	68 B	1,094.91	3.039385
70 Battle, 1901 d. m.	42 19 24.449	755.9	335 50 37.0	155 50 46.0	67 C. P. R	768.00	2.885361
	83 03 21.065	482.3	66 51 22.0	246 51 01.0	68 B	766.96	2.884772
			19 50 07.0	199 49 56.0	65 M. C. R	1,030.15	3.012901
72 Woodward, 1901 d. m.	42 19 35.941	1,108.9	33 23 17.0	213 22 57.0	67 C. P. R	1,262.03	3.101071
	83 02 37.014	847.5	70 42 51.0	250 42 22.0	70 Battle	1,068.66	3.028842
Hurley, 1901 d. m.	42 19 09.433	291.1	115 22 26.0	295 21 58.0	70 Battle	1,084.93	3.035402
	83 02 38.255	876.1	181 59 27.0	1 59 27.0	72 Woodward	818.37	2.912953
71 Windsor, 1901 d. m.	42 19 13.492	416.3	101 39 54.0	281 39 06.0	70 Battle	1,680.78	3.225507
	83 02 09.181	210.2	137 23 03.0	317 22 44.0	72 Woodward	941.28	2.973720
73 Track, 1901 d. m.	42 19 15.072	465.1	100 34 44.0	280 33 58.0	70 Battle	1,585.29	3.200106
	83 02 13.013	298.0	139 31 04.0	319 30 47.0	72 Woodward	846.58	2.927669
74 Elevator, 1901 d. m.	42 19 44.500	1,373.0	11 28 19.0	191 28 14.0	73 Track	926.51	2.966853
	83 02 04.967	113.7	70 12 33.0	250 12 11.0	72 Woodward	779.94	2.892059
73 Track Offset, 1901	42 19 14.979	462.3	191 56 22.0	11 56 28.0	74 Elevator	931.02	2.968962
	83 02 13.378	306.3	251 02 08.0	71 02 09.0	73 Track	8.852	0.947
77 Waterworks, 1901 d. m.	42 19 27.064	835.1	71 02 40.0	251 02 09.0	73 Track	1,138.83	3.056461
	83 01 25.979	594.8	121 04 43.0	301 04 17.0	74 Elevator	1,042.29	3.017994
			88 17 25.0	268 16 08.0	70 Battle	2,636.51	3.421034
			99 33 50.0	279 33 02.0	72 Woodward	1,649.53	3.217359
City Hall Flagstaff, Detroit, 1873	42 19 52.185	1,610.2					
	83 02 50.686	1,160.5					
City Hall Flagstaff, Detroit, 1903	42 19 52.145	1,608.9	291 43 48.0	111 44 45.0	77 Waterworks	2,089.54	3.320046
	83 02 50.749	1,161.9	322 55 57.0	142 56 23.0	73 Track	1,433.51	3.156403

Majestic Building Flagstaff, Detroit. 1901	42 19 54.290	1,675.0	293 24 58.0	113 25 55.0	77 Waterworks	2,113.20	3.324938
	83 02 50.664	1,160.0	324 31 45.0	144 32 10.0	73 Track	1,485.76	3.171952
Wayne County Court-House, 1903	42 19 55.053	1,698.6	298 52 03.0	118 52 49.0	77 Waterworks	1,788.55	3.252501
	83 02 34.387	787.3	338 21 55.0	158 22 10.0	73 Track	1,327.15	3.122921
76 Dry Dock, 1901 d. m.	42 19 53.968	1,665.1	346 50 15.0	166 50 20.0	77 Waterworks	852.55	2.930721
	83 01 34.460	789.0	36 32 05.0	216 31 39.0	73 Track Offset	1,497.20	3.175276
79 Bridge, 1901 d. m.	42 19 32.227	994.3	78 01 37.0	258 01 15.0	77 Waterworks	767.86	2.88528
	83 00 53.177	1,217.7	125 22 01.0	305 21 34.0	76 Dry Dock	1,159.07	3.06411
			78 01 37.0	258 01 37.0	79 Bridge Offset	8.23	0.915
79 Bridge Offset, 1901	42 19 32.172	992.6	78 01 37.0	258 01 15.0	77 Waterworks	759.63	2.880602
	83 00 53.529	1,225.7	125 40 03.0	305 39 36.0	76 Dry Dock	1,153.51	3.062024
80 Campau, 1901 d. m.	42 20 08.493	262.0	352 08 26.0	172 08 30.0	79 Bridge Offset	1,131.33	3.053586
	83 01 00.285	6.5	24 43 00.0	204 42 42.0	77 Waterworks	1,407.21	3.148360
78 Tower, 1901	42 20 10.918	336.9	1 46 12.0	181 46 11.0	79 Bridge	1,194.40	3.077148
	83 00 51.566	1,180.6	61 57 56.0	241 57 27.0	76 Dry Dock	1,112.63	3.046346
			30 12 58.0	210 12 35.0	77 Waterworks	1,565.89	3.194756
82 Soap, 1901 d. m.	42 20 19.856	612.6	16 23 16.0	196 23 03.0	79 Bridge	1,531.79	3.185202
	83 00 34.305	785.4	55 05 46.0	235 05 35.0	78 Tower	481.90	2.682963
81 Walkerville, 1901 d. m.	42 19 35.090	1,082.7	83 59 47.0	263 59 22.0	79 Bridge	844.11	2.926399
	83 00 16.514	378.1	163 34 25.0	343 34 13.0	82 Soap	1,440.02	3.158373
88 Belle Isle, 1901 d. m.	42 20 07.756	239.3	50 21 04.0	230 20 25.0	79 Bridge	1,717.83	3.234980
	82 59 55.413	1,268.7	112 45 12.0	292 44 46.0	82 Soap	965.45	2.984728
			94 20 46.0	274 20 09.0	78 Tower	1,289.26	3.110341
			25 36 48.0	205 36 34.0	81 Walkerville	1,117.71	3.048335
85 Yard, 1901 d. m.	42 19 35.494	1,095.1	139 55 46.0	319 55 12.0	82 Soap	1,788.79	3.252561
	82 59 44.006	1,007.6	165 17 50.0	345 17 43.0	88 Belle Isle	1,029.15	3.012479
			89 02 39.0	269 02 18.0	81 Walkerville	744.53	2.871882
Belle Isle Flagstaff, 1901	42 20 07.278	224.6	51 43 03.0	231 42 23.0	79 Bridge	1,745.42	3.241896
	82 59 53.347	1,221.4	112 29 14.0	292 28 46.0	82 Soap	1,014.87	3.006412
⊙ 83 Wagon, 1901 d. m.	42 19 38.452	1,186.5	161 03 59.0	341 03 46.0	82 Soap	1,350.61	3.13053
	83 00 15.162	347.2	206 33 59.0	26 34 12.0	88 Belle Isle	1,010.90	3.00471
90 Driveway, 1901 d. m.	42 20 00.063	1.9	29 31 13.0	209 31 01.0	85 Yard	871.16	2.940098
	82 59 25.261	578.3	108 58 34.0	288 58 14.0	88 Belle Isle	730.06	2.863364
Sign, 1901	42 19 36.724	1,133.1	158 13 21.0	338 13 10.0	88 Belle Isle	1,031.10	3.01330
	82 59 38.703	886.2	203 08 59.0	23 09 00.0	90 Driveway	783.18	2.89386
Hatch, 1901	42 20 18.829	581.0	347 07 21.0	167 07 25.0	90 Driveway	593.96	2.773763
	82 59 31.043	710.6	12 31 03.0	192 30 55.0	85 Yard	1,369.65	3.136613

TABLE 1.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, Detroit River*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
89 Potash, 1901 d. m.	42 19 56.725	1,750.2	72 34 20.0	252 33 19.0	85 Yard	2,186.25	3.339701
	82 58 12.909	295.5	93 33 51.0	273 33 03.0	90 Driveway	1,659.67	3.220025
98 East Belle Isle, 1901 d. m.	42 20 12.634	389.8	308 08 12.0	128 08 31.0	89 Potash	794.88	2.900296
	82 58 40.218	920.7	69 23 24.0	249 22 54.0	90 Driveway	1,101.80	3.042104
			51 53 11.0	231 52 29.0	85 Yard	1,856.45	3.268684
Belle Isle Light-house, 1901	42 20 24.465	754.9	75 54 10.0	255 53 27.0	98 East Belle Isle	1,498.13	3.175554
	82 57 36.751	841.4	44 02 54.0	224 02 30.0	89 Potash	1,190.80	3.075842
91 Ice, 1901 d. m.	42 19 58.701	1,811.2	87 02 28.0	267 01 53.0	89 Potash	1,180.02	3.071891
	82 57 21.440	490.9	103 24 49.0	283 23 56.0	98 East Belle Isle	1,854.10	3.268133
106 Island Light, 1901 d. m.	42 20 23.737	732.4	335 44 34.0	155 44 44.0	91 Ice	847.23	2.928006
	82 57 36.645	838.9	76 45 40.0	256 44 57.0	98 East Belle Isle	1,495.20	3.174701
			44 53 43.0	224 53 19.0	89 Potash	1,176.48	3.070582
			195 29 36.0	15 29 52.0	108 Crystal	2,061.20	3.314125
			262 44 58.0	82 45 29.0	93 Traub	1,083.05	3.034655
93 Traub, 1901 d. m.	42 20 28.165	869.0	38 37 46.0	218 37 25.0	91 Ice	1,163.62	3.065808
	82 56 49.716	1,138.0	82 45 29.0	262 44 58.0	106 Island Light	1,083.05	3.034636
			121 53 19.0	301 52 24.0	102 Preserver	2,164.01	3.335259
86 Boat, 1901 d. m.	42 20 19.654	606.4	28 28 03.0	208 27 57.0	88 Belle Isle	417.60	2.620756
	82 59 46.720	1,069.5	90 19 58.0	270 19 26.0	82 Soap	1,089.38	3.037175
84 Pier, 1901 d. m.	42 20 40.135	1,238.3	337 10 24.0	157 10 32.0	86 Boat	685.61	2.836083
	82 59 58.340	1,335.5	52 46 14.0	232 45 50.0	82 Soap	1,034.09	3.014562
92 Scott, 191 d. m.	42 21 03.937	121.4	22 54 08.0	202 53 51.0	86 Boat	1,483.27	3.171221
	82 59 21.507	492.3	48 56 36.0	228 56 11.0	84 Pier	1,118.12	3.048490
94 Yacht, 1901 d. m.	42 20 49.336	1,522.2	61 07 48.0	241 06 59.0	86 Boat	1,896.44	3.277938
	82 58 34.177	782.3	112 35 08.0	292 34 36.0	92 Scott	1,173.28	3.069402
			81 37 28.0	261 36 31.0	84 Pier	1,947.29	3.289435
100 Park, 1901 d. m.	42 21 15.516	478.7	355 21 57.0	175 21 59.0	94 Yacht	810.46	2.908727
	82 58 37.039	848.1	70 39 43.0	250 39 13.0	92 Scott	1,078.68	3.032892
102 Preserver, 1901 d. m.	42 21 05.206	160.6	48 30 21.0	228 30 04.0	94 Yacht	739.06	2.868677
	82 58 09.995	228.8	117 12 11.0	297 11 53.0	100 Park	695.95	2.842580
			88 38 09.0	268 37 20.0	92 Scott	1,637.23	3.214112

108 Crystal, 1901 d. m.	42 21 28.112	867.3	61 43 37.0	241 42 58.0	102 Preserver	1,491.80	3.173713
	82 57 12.594	288.4	78 38 17.0	258 37 20.0	100 Park	1,971.38	3.294770
			344 11 28.0	164 11 44.0	93 Traub	1,922.38	3.283836
110 Windmill Point, 1901 d. m.	42 21 30.729	948.1	36 15 50.0	216 15 09.0	93 Traub	2,393.98	3.379119
	82 55 47.862	1,095.8	87 37 28.0	267 36 31.0	108 Crystal	1,940.89	3.287996
Waterworks Standpipe Tower, Detroit, 1901	42 21 34.271	1,057.4	313 49 23.0	133 49 51.0	102 Preserver	1,295.12	3.112308
	82 58 50.821	1,163.6	344 38 20.0	164 38 32.0	94 Yacht	1,437.87	3.157722
95 Peche Isle, 1901 d. m.	42 20 48.869	1,507.8	42 51 12.0	222 50 55.0	93 Traub	871.36	2.940200
	82 56 23.828	545.5	137 20 12.0	317 19 39.0	108 Crystal	1,646.80	3.216636
			212 30 37.0	32 31 01.0	110 Windmill Point	1,531.65	3.185159
Walker, 1901	42 20 46.056	1,421.0	70 35 00.0	250 34 14.0	93 Traub	1,660.05	3.220115
	82 55 41.326	946.0	173 48 32.0	353 48 27.0	110 Windmill Point	1,386.47	3.141908
			121 51 27.0	301 50 20.0	108 Crystal	2,459.18	3.390788
Windmill Point Light-house, 1901 (built 1875)	42 21 30.389	937.6	235 20 11.0	55 20 11.0	110 Windmill Point	18.45	1.2660
	82 55 48.525	1,110.5	353 07 59.0	173 08 04.0	Walker	1,377.79	3.139191
Windmill Point Light-house, 1873 (built in 1838)	42 21 29.950	924.1					
	82 55 48.851	1,118.0					
99 Peach, 1897-1901 d. m.	42 20 46.024	1,420.1	173 15 30.0	353 15 25.0	Windmill Point Light-house 1901.	1,378.48	3.139395
	82 55 41.452	948.8					
			173 55 54.0	353 55 49.0	110 Windmill Point	1,387.14	3.142122
			250 57 01.0	70 57 01.0	Walker	3.048	0.484
Tecumseh Church, 1897	42 18 40.4	1,246.7					
	82 53 11.4	261.1					

TABLE 2.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, St. Clair River.*

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
Huron Point, 1871-1902 d. m.	42 33 58.135	1,793.8					
	82 47 04.827	110.1					
St. Clair Flats Rear Range Light, 1871-1902	42 32 21.686	669.1	110 57 57.0	290 54 06.4	Huron Point	8,329.5	3.920618
	82 41 23.830	543.8					
182, 1902 d. m.	42 35 57.51	1,774.6	350 10 52.5	170 11 26.6	St. Clair Flats Rear Range Light.	6,758.0	3.829821
	82 42 14.34	327.0	60 57 11.6	240 53 55.1	Huron Point	7,579.4	3.879633
180, 1902 d. m.	42 34 42.07	1,298.2	28 50 04.1	208 48 53.4	St. Clair Flats Rear Range Light.	4,944.2	3.694099
	82 39 39.34	897.0	123 22 56.7	303 21 11.8	182	4,231.8	3.626521
185 Furtaw, 1901 d. m.	42 32 27.68	854.1	86 01 20.9	266 00 02.4	St. Clair Flats Rear Range Light.	2,657.7	3.424512
	82 39 27.64	630.7	176 19 14.5	356 19 06.6	180	4,155.4	3.618609
183 Southeast Bend, 1901 d. m.	42 33 15.79	487.2	64 37 47.3	244 36 14.6	185 Furtaw	3,462.5	3.539392
	82 37 10.54	240.5	128 07 38.1	308 05 57.4	180	4,313.8	3.634856
			73 54 52.5	253 52 00.9	St. Clair Flats Rear Range Light.	6,015.5	3.779272
176 Marsh, 1901 d. m.	42 32 22.44	692.4	92 24 57.3	272 23 02.9	185 Furtaw	3,865.4	3.587195
	82 36 38.40	876.3	155 59 28.9	335 59 07.2	183 Southeast Bend	1,802.1	3.255777
178 Lake, 1901 d. m.	42 31 24.90	768.3	167 29 05.2	347 28 52.5	185 Furtaw	1,984.4	3.297634
	82 39 08.80	200.9	242 38 11.8	62 39 53.5	176 Marsh	3,864.5	3.587089
			218 15 10.2	38 16 30.6	183 Southeast Bend	4,357.7	3.639255
St. Clair Flats Canal Upper Light, 1901	42 32 02.73	84.2	233 14 59.4	53 15 30.0	185 Furtaw	1,287.1	3.109602
	82 40 12.84	293.0	308 36 20.3	128 37 03.6	178 Lake	1,870.5	3.271950
St. Clair Flats Canal Lower Light, 1901	42 31 09.70	299.3	221 03 49.8	41 04 32.0	St. Clair Flats Canal Upper Light.	2,170.4	3.336530
	82 41 15.31	349.5	260 45 47.0	80 47 12.5	178 Lake	2,925.6	3.466211
			225 35 25.3	45 36 38.1	185 Furtaw	3,439.2	3.536452
181 Drouillard, 1901 d. m.	42 33 05.11	157.7	48 47 36.5	228 46 52.0	176 Marsh	1,998.4	3.300684
	82 35 32.51	741.9	98 23 24.6	278 22 18.3	183 Southeast Bend	2,260.5	3.354213
174 Bassett, 1901 d. m.	42 32 28.07	866.2	85 36 03.9	265 34 57.1	176 Marsh	2,259.5	3.354010
	82 34 59.67	1361.7	146 45 25.4	326 45 03.2	181 Drouillard	1,366.7	3.135671
			116 15 45.5	296 14 17.3	183 Southeast Bend	3,329.2	3.522337

172 Foot of Squirrel Island, 1901 .... d. m..	42 33 17.17	529.8	24 40 15.8	204 39 55.2	174 Bassett	1,667.2	3.221983
	82 34 29.18	665.9	75 34 03.0	255 33 20.2	181 Drouillard	1,492.1	3.173791
179 State or Church, 1901 .... d. m..	42 33 50.50	1,558.3	323 32 22.4	143 32 44.9	172 Foot of Squirrel Id	1,278.9	3.106842
	82 35 02.49	56.8	26 03 34.0	206 03 13.7	181 Drouillard	1,559.1	3.192884
			358 33 08.3	178 33 10.0	174 Bassett	2,544.5	3.405598
170 (opposite Maple Leaf), 1901 .... d. m..	42 34 11.53	355.8	16 41 05.6	196 40 50.7	172 Foot of Squirrel Id	1,751.1	3.243311
	82 34 07.14	162.9	62 48 30.3	242 47 52.9	179 State or Church	1,419.5	3.152123
177 St. Aubin (Maple Leaf Base), 1901 .... d. m..	42 34 25.30	780.7	305 04 22.0	125 04 40.0	170 (opposite Maple Leaf)	739.8	2.869105
	82 34 33.68	768.2	31 27 43.2	211 27 23.7	179 State or Church	1,258.9	3.100002
			357 11 58.8	177 12 01.5	172 Foot of Squirrel Id	2,105.0	3.323257
175 Fisher (Maple Leaf Base), 1901 .... d. m..	42 34 38.13	1,176.6	355 03 30.7	175 03 32.8	170 (opposite Maple Leaf)	823.9	2.915897
	82 34 10.25	233.7	53 28 53.4	233 28 37.5	177 St. Aubin (Maple Leaf Base).	665.019	2.8228339
168 Reserve, 1901 .... d. m..	42 34 26.67	823.0	43 52 38.8	223 52 25.5	170 (opposite Maple Leaf)	648.3	2.811802
	82 33 47.44	1,082.1	124 11 49.6	304 11 34.2	175 Fisher	629.0	2.798680
			87 42 40.8	267 42 09.8	177 St. Aubin	1,055.6	3.023504
173 Lacroix, 1901 .... d. m..	42 34 51.67	1,594.4	7 10 25.1	187 10 22.2	168 Reserve	777.3	2.890613
	82 33 43.18	984.5	55 55 03.3	235 54 45.0	175 Fisher	745.4	2.872382
166 Ed. Noddie, 1901 .... d. m..	42 34 51.17	1,579.0	44 29 24.2	224 29 02.2	168 Reserve	1,059.3	3.025020
	82 33 14.89	339.5	91 22 57.0	271 22 37.9	173 Lacroix	645.4	2.809821
			72 20 09.1	252 19 31.5	175 Fisher	1,325.1	3.122238
171 McDougall, 1901 .... d. m..	42 35 13.24	408.5	353 06 52.9	173 06 55.3	166 Ed Noddie	686.1	2.836377
	82 33 18.50	421.8	40 13 30.2	220 13 13.5	173 Lacroix	871.7	2.940378
164 William, 1901 .... d. m..	42 35 09.74	300.5	47 33 35.6	227 33 17.0	166 Ed. Noddie	848.9	2.928843
	82 32 47.42	1,081.2	98 41 23.2	278 41 02.2	171 McDougall	716.9	2.855437
			66 20 17.4	246 19 39.6	173 Lacroix	1,388.4	3.142507
169 Rosher, 1901 .... d. m..	42 36 00.47	14.5	15 35 36.9	195 35 23.9	164 William	1,625.3	3.210924
	82 32 28.26	644.3	38 10 23.8	218 09 49.8	171 McDougall	1,853.5	3.267984
162 Head of Squirrel Island, 1901 .... d. m..	42 35 38.91	1,200.6	38 30 29.4	218 30 08.2	164 William	1,150.3	3.060797
	82 32 16.01	365.0	157 13 56.8	337 13 48.5	169 Rosher	721.5	2.858261
			60 56 25.4	240 55 43.1	171 McDougall	1,630.0	3.212188
160 MacNoddie, 1901 .... d. m..	42 36 13.93	429.8	46 47 18.8	226 46 44.7	162 Head of Squirrel Id	1,578.0	3.198118
	82 31 25.57	583.0	73 48 16.9	253 47 34.5	169 Rosher	1,488.3	3.172693
167 Folkert, 1901 .... d. m..	42 36 45.43	1,401.8	315 41 59.5	135 42 27.7	160 MacNoddie	1,358.3	3.132988
	82 32 07.18	163.6	19 06 15.2	199 06 00.9	169 Rosher	1,468.3	3.166807
			5 36 06.3	185 36 00.4	162 Head of Squirrel Id	2,062.6	3.314412
165 Dana, 1901 .... d. m..	42 37 30.88	952.9	4 24 47.1	184 24 41.7	160 MacNoddie	2,381.6	3.376870
	82 31 17.53	399.5	38 54 21.0	218 53 47.4	167 Folkert	1,802.0	3.255758

TABLE 2.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, St. Clair River*—Continued.

Station.		Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
		° ′ ″		° ′ ″	° ′ ″			
158 Sands, 1901	d.	42 37 06.70	206.7	30 55 41.3	210 55 12.3	160 MacNoddie	1,898.1	3.278309
	m.	82 30 42.77	974.7	133 17 59.8	313 17 36.3	165 Dana	1,088.3	3.036731
				71 10 37.3	251 09 39.9	167 Folkert	2,032.6	3.308053
163 Pfister, 1901	d.	42 37 50.15	1,547.5	342 45 53.3	162 46 05.7	158 Sands	1,403.6	3.147251
	m.	82 31 01.02	23.2	32 19 53.8	212 19 42.7	165 Dana	703.3	2.847167
156 Schocomon, 1901	d.	42 37 56.80	1,752.7	12 02 47.8	192 02 38.0	158 Sands	1,580.7	3.198850
	m.	82 30 28.30	644.7	74 36 34.5	254 36 12.3	163 Pfister	773.4	2.888393
				54 31 26.7	234 30 53.3	165 Dana	1,377.6	3.139126
161 Harrow, 1901	d.	42 38 12.75	393.4	310 27 08.6	130 27 25.8	156 Schocomon	758.3	2.879837
	m.	82 30 53.62	1,221.5	13 35 35.5	193 35 30.5	163 Pfister	717.4	2.855762
154 Menten, 1900	d.	42 38 44.18	1,363.3	10 21 03.9	190 20 56.0	156 Schocomon	1,486.1	3.172054
	m.	82 30 16.58	377.7	41 01 47.4	221 01 22.3	161 Harrow	1,285.7	3.109132
159 O'Leary, 1900	d.	42 38 53.77	1,659.2	291 11 37.1	111 11 59.8	154 Menten	818.5	2.913008
	m.	82 30 50.08	1,140.8	3 39 01.0	183 38 58.6	161 Harrow	1,268.4	3.103269
				344 14 06.8	164 14 21.7	156 Schocomon	1,826.6	3.261636
152 Revera, 1900	d.	42 39 27.49	848.3	352 44 12.0	172 44 17.1	154 Menten	1,347.3	3.129463
	m.	82 30 24.06	548.0	29 40 08.4	209 39 50.8	159 O'Leary	1,197.5	3.078281
157 O'Learys Dock, 1900	d.	42 39 19.47	600.8	248 59 51.0	69 00 10.2	152 Revera	690.8	2.839350
	m.	82 30 52.37	1,193.0	356 13 50.3	176 13 51.9	159 O'Leary	794.7	2.900207
				323 10 25.1	143 10 49.5	154 Menten	1,360.3	3.133642
150 McDonald, 1900	d.	42 39 48.61	1,500.0	358 41 07.4	178 41 07.8	152 Revera	651.9	2.814167
	m.	82 30 24.71	562.6	35 00 48.8	215 00 30.1	157 O'Learys Dock	1,097.9	3.040582
155 Robbins, 1900	d.	42 39 59.22	1,827.4	298 02 43.3	118 03 01.6	150 McDonald	696.0	2.842615
	m.	82 30 51.69	1,177.0	0 43 44.9	180 43 44.4	157 O'Learys Dock	1,226.6	3.088715
				327 15 57.7	147 16 16.6	152 Revera	1,163.8	3.065866
148 Hart, 1900	d.	42 40 30.18	931.3	17 51 32.8	197 51 20.5	150 McDonald	1,347.5	3.129522
	m.	82 30 06.57	149.6	47 05 13.1	227 04 42.5	155 Robbins	1,402.9	3.147030
153 Cottrell, 1900	d.	42 40 37.98	1,171.9	288 34 22.3	108 34 43.6	148 Hart	755.7	2.878360
	m.	82 30 38.03	865.9	14 34 34.8	194 34 25.5	155 Robbins	1,235.8	3.091952
				348 44 28.1	168 44 37.1	150 McDonald	1,553.2	3.191226
151 Michigan, 1900	d.	42 41 14.32	441.9	346 10 41.8	166 10 51.8	148 Hart	1 402.5	3.146906
	m.	82 30 21.28	484.5	18 46 56.1	198 46 44.7	153 Cottrell	1 1[illegible]4.2	3.073431

146 Burnham, 1900	d. m.	42 41 34.42	1,062.1	21 18 46.4	201 18 23.4	148 Hart	2,127.6	3.327893
		82 29 32.60	742.0	60 46 01.8	240 45 28.8	151 Michigan	1,269.9	3.103762
				40 32 47.5	220 32 03.0	153 Cottrell	2,291.5	3.360116
149 Craig, 1900	d. m.	42 41 35.88	1,107.1	272 32 44.1	92 33 14.1	146 Burnham	1,009.8	3.004242
		82 30 16.92	385.1	8 29 08.0	188 29 05.0	151 Michigan	672.5	2.827712
147 Lester, 1900	d. m.	42 42 21.78	672.1	343 52 55.2	163 53 07.8	146 Burnham	1,520.9	3.182100
		82 29 51.15	1,164.2	22 29 58.6	202 29 41.1	149 Craig	1,532.9	3.185501
144 Smith, 1900	d. m.	42 42 28.15	868.6	27 48 26.0	207 48 00.0	146 Burnham	1,874.1	3.272786
		82 28 54.19	1,233.4	81 22 52.3	261 22 13.7	147 Lester	1,311.0	3.117606
				49 25 31.1	229 24 35.0	149 Craig	2,479.1	3.394301
142 Condick, 1900	d. m.	42 43 36.86	1,137.4	7 47 06.9	187 46 58.3	144 Smith	2,140.0	3.330414
		82 28 41.45	943.0	34 23 49.5	214 23 02.2	147 Lester	2,807.6	3.448339
145 Holland, 1900	d. m.	42 43 28.17	869.2	253 32 03.8	73 32 30.9	142 Condick	946.9	2.976305
		82 29 21.37	486.2	341 31 58.6	161 32 17.0	144 Smith	1,952.5	3.290583
143 Young, 1900	d. m.	42 44 06.35	195.9	315 02 04.1	135 02 31.2	142 Condick	1,286.0	3.109229
		82 29 21.40	486.9	359 57 57.7	179 57 57.7	145 Holland	1,178.3	3.071238
140 Stokes, 1900	d. m.	42 44 04.63	142.9	0 52 48.8	180 52 48.4	142 Condick	857.1	2.932987
		82 28 40.88	930.0	93 17 42.0	273 17 14.5	143 Young	923.3	2.965360
				39 18 35.2	219 18 07.7	145 Holland	1,454.2	3.162629
141 Scott, 1900	d. m.	42 44 31.98	986.8	322 43 16.2	142 43 35.4	140 Stokes	1,060.4	3.025471
		82 29 09.11	207.2	19 28 05.4	199 27 57.1	143 Young	838.7	2.923621
138 McGregor, 1900	d. m.	42 44 32.82	1,012.7	22 28 04.8	202 27 54.1	140 Stokes	941.2	2.973678
		82 28 25.06	569.9	88 31 09.2	268 30 39.3	141 Scott	1,002.2	3.000948
				57 29 34.0	237 28 55.8	143 Young	1,519.6	3.181722
139 Belle River, Southwest Base, 1900	d. m.	42 45 03.04	93.8	320 17 06.9	140 17 30.0	138 McGregor	1,212.1	3.083525
		82 28 59.11	1,344.3	13 20 48.9	193 20 42.1	141 Scott	985.0	2.993425
137 Recor Belle River Base Station, 1900	d. m.	42 45 22.14	683.2	357 09 14.7	177 09 17.0	138 McGregor	1,523.7	3.182888
		82 28 28.39	645.6	49 51 13.5	229 50 52.7	139 Southwest Base	914.08	2.960983
				30 53 52.5	210 53 24.7	141 Scott	1,803.7	3.256154
136 Stratton, 1900	d. m.	42 45 09.48	292.5	30 52 26.3	210 52 06.1	138 McGregor	1,317.6	3.119788
		82 27 55.34	1,258.5	117 28 37.6	297 28 15.2	137 Recor	847.2	2.927978
				82 12 42.0	262 11 58.5	139 Southwest Base	1,474.1	3.165514
135 Rankin, 1900	d. m.	42 45 46.49	1,434.5	335 35 45.4	155 36 00.9	136 Stratton	1,254.1	3.098346
		82 28 18.12	412.0	17 15 51.2	197 15 44.2	137 Recor	786.7	2.895811
134 Dingmann, 1900	d. m.	42 45 42.93	1,324.7	11 05 29.1	191 05 23.1	136 Stratton	1,051.8	3.021930
		82 27 46.44	1,056.0	98 40 53.7	278 40 32.2	135 Rankin	728.7	2.862573
				56 05 28.5	236 05 00.1	137 Recor	1,149.4	3.060484

TABLE 2.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, St. Clair River*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
133 Hammond, 1900 d. m.	42 45 59.22	1,827.4	305 58 10.6	125 58 31.3	134 Dingmann	855.8	2.932369
	82 28 16.90	384.2	4 02 48.4	184 02 47.6	135 Rankin	393.7	2.595177
132 Campbell, 1900 d. m.	42 45 59.74	1,843.4	353 34 47.3	173 34 49.0	134 Dingmann	521.9	2.717605
	82 27 49.01	1,114.3	88 33 40.3	268 33 21.4	133 Hammond	634.4	2.802371
			58 18 50.3	238 18 30.5	135 Rankin	778.0	2.890980
131 China, 1900 d. m.	42 46 24.75	763.7	319 18 44.2	139 19 04.0	132 Campbell	1,017.8	3.007646
	82 28 18.19	413.5	357 52 09.9	177 52 10.8	133 Hammond	788.3	2.896679
130 Bowen, 1900 d. m.	42 46 28.13	868.0	350 38 23.5	170 38 27.8	132 Campbell	887.9	2.948385
	82 27 55.36	1,258.5	78 38 05.2	258 37 49.7	131 China	529.4	2.723803
			28 46 10.0	208 45 55.4	133 Hammond	1,017.7	3.007612
128 Elm Point, 1900 d. m.	42 46 45.66	1,408.9	344 26 23.0	164 26 27.5	130 Bowen	561.5	2.749358
	82 28 01.98	45.0	29 43 26.0	209 43 15.0	131 China	743.1	2.871010
129 Wee Willows, 1900 d. m.	42 46 52.57	1,622.2	291 46 28.5	111 46 44.4	128 Elm Point	574.4	2.759213
	82 28 25.45	578.5	349 06 57.9	169 07 02.8	131 China	874.1	2.941562
			317 47 00.9	137 47 20.2	130 Bowen	1,018.1	3.007781
126 Fishhouse, 1900 d. m.	42 47 10.13	312.6	351 48 32.5	171 48 35.7	128 Elm Point	762.7	2.882339
	82 28 06.76	153.7	38 05 43.4	218 05 30.7	129 Wee Willows	688.4	2.837860
127 White House, 1900 d. m.	42 47 10.23	315.7	270 18 44.5	90 19 01.3	126 Fishhouse	563.0	2.750486
	82 28 31.53	716.7	345 45 42.6	165 45 46.7	129 Wee Willows	562.2	2.749857
			318 27 11.7	138 27 31.7	128 Elm Point	1,012.7	3.005500
124 Big Willows, 1900 d. m.	42 47 35.57	1,097.6	342 45 11.6	162 45 18.9	126 Fishhouse	822.1	2.914902
	82 28 17.49	397.5	22 12 23.5	202 12 14.0	127 White House	844.7	2.926676
125 Vista, 1900 d. m.	42 47 29.37	906.3	253 32 20.6	73 32 40.0	124 Big Willows	675.9	2.829877
	82 28 46.00	1,045.4	330 52 24.8	150 52 34.6	127 White House	676.0	2.829939
			303 38 26.3	123 38 52.9	126 Fishhouse	1,071.4	3.029962
122 Open, 1900 d. m.	42 47 56.55	1,745.0	344 13 10.9	164 13 16.4	124 Big Willows	672.4	2.827650
	82 28 25.53	580.1	29 01 35.4	209 01 21.5	125 Vista	959.0	2.981831
123 Sumac, 1900 d. m.	42 47 51.29	1,582.7	255 03 33.3	75 03 51.5	122 Open	629.3	2.798859
	82 28 52.28	1,188.0	348 04 51.5	168 04 55.8	125 Vista	691.3	2.839646
			301 30 25.1	121 30 48.8	124 Big Willows	927.7	2.967416
120 Flats, 1900 d. m.	42 48 10.71	330.5	324 37 03.9	144 37 13.2	122 Open	536.1	2.729246
	82 28 39.19	890.6	26 24 32.5	206 24 23.6	123 Sumac	669.1	2.825515

121 Locust Point, 1900 d. m.	42 48 01.74	53.7	238 35 42.1	58 35 55.7	120 Flats	531.1	2.725144
	82 28 59.14	1,343.9	334 14 16.7	154 14 21.4	123 Sumac	358.2	2.554128
			281 51 24.8	101 51 47.7	122 Open	780.4	2.892295
119 Oakland, 1900 d. m.	42 48 43.14	1,331.2	323 04 09.0	143 04 31.5	120 Flats	1,251.8	3.097545
	82 29 12.29	279.2	346 49 47.6	166 49 56.5	121 Locust Point	1,311.9	3.117907
118 Beachmoor, 1900 d. m.	42 48 30.32	935.6	356 34 45.2	176 34 46.3	120 Flats	606.0	2.782486
	82 28 40.78	926.6	118 56 13.4	298 55 52.0	119 Oakland	818.0	2.912768
			25 19 10.9	205 18 58.4	121 Locust Point	975.3	2.989154
116 Elevator, 1900 d. m.	42 48 49.83	1,537.7	8 35 31.1	188 35 28.4	118 Beachmoor	609.0	2.784595
	82 28 36.78	835.6	75 39 23.0	255 38 58.9	119 Oakland	832.8	2.920558
117 Diamond, 1900 d. m.	42 49 03.71	114.5	302 36 20.3	122 36 40.3	116 Elevator	794.5	2.900108
	82 29 06.23	141.5	12 13 49.0	192 13 44.9	119 Oakland	649.3	2.812426
			330 41 25.4	150 41 42.7	118 Beachmoor	1,181.5	3.072443
114 Courtright, 1900 d. m.	42 49 31.55	973.6	17 51 10.2	197 50 57.8	116 Elevator	1,352.6	3.131158
	82 28 18.53	420.9	51 35 47.6	231 35 15.2	117 Diamond	1,383.1	3.140864
115 Safe, 1900 d. m.	42 49 30.16	930.7	267 45 33.3	87 46 06.1	114 Courtright	1,097.6	3.040463
	82 29 06.81	154.7	359 05 04.8	179 05 05.3	117 Diamond	816.6	2.911986
			331 15 57.0	151 16 17.5	116 Elevator	1,419.3	3.152094
113 Elm, 1900 d. m.	42 50 11.51	355.2	332 54 56.1	152 55 15.0	114 Courtright	1,385.0	3.141448
	82 28 46.28	1,051.1	20 04 18.3	200 04 04.3	115 Safe	1,358.5	3.133048
112 Lower Mooretown, 1900 d. m.	42 49 58.23	1,796.9	16 58 30.6	196 58 23.1	114 Courtright	860.8	2.934910
	82 28 07.46	169.4	114 55 52.4	294 55 26.0	113 Elm	972.4	2.987830
			57 17 03.3	237 16 23.0	115 Safe	1,602.3	3.204751
111 Corn, 1900 d. m.	42 50 31.71	978.5	331 47 38.0	151 47 54.6	112 Lower Mooretown	1,172.1	3.068979
	82 28 31.85	723.3	27 44 42.5	207 44 32.7	113 Elm	704.1	2.847630
110 Upper Mooretown, 1900 d. m.	42 50 30.43	939.0	11 51 53.1	191 51 46.8	112 Lower Mooretown	1,015.3	3.006576
	82 27 58.27	1,323.3	92 57 39.0	272 57 16.2	111 Corn	763.6	2.882894
			61 50 34.6	241 50 01.9	113 Elm	1,236.9	3.092318
108 Twin Hickory, 1900 d. m.	42 50 47.35	1,461.1	1 39 26.9	181 39 26.4	110 Upper Mooretown	522.3	2.717914
	82 27 57.60	1,308.0	58 10 41.5	238 10 18.2	111 Corn	915.3	2.961571
109 Pasture, 1900 d. m.	42 50 54.83	1,691.9	288 50 12.4	108 50 32.7	108 Twin Hickory	715.1	2.854356
	82 28 27.41	622.3	8 02 55.2	188 02 52.2	111 Corn	720.7	2.857745
			318 41 23.0	138 41 42.8	110 Upper Mooretown	1,002.4	3.001046
106 New Calf, 1900 d. m.	42 51 17.78	548.7	11 47 55.7	191 47 49.8	108 Twin Hickory	959.5	2.982028
	82 27 48.96	1,111.6	50 56 50.1	230 56 24.0	109 Pasture	1,124.1	3.050806
105 Elwood, 1900 d. m.	42 51 23.43	723.0	280 46 14.6	100 46 42.0	106 New Calf	932.1	2.969456
	82 28 29.29	665.0	327 07 06.1	147 07 27.7	108 Twin Hickory	1,325.9	3.122496

TABLE 2.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation. St. Clair River*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
107 Switch, 1900 ..... d. m..	42 50 55.71	1,719.1	184 59 23.1	4 59 25.3	105 Elwood	858.5	2.933752
	82 28 32.58	739.8	235 28 56.2	55 29 25.9	106 New Calf	1,201.9	3.079882
104 Gravel, 1900 ..... d. m..	42 51 50.58	1,560.8	4 42 22.0	184 42 19.5	106 New Calf	1,015.5	3.006663
	82 27 45.29	1,028.1	50 01 01.1	230 00 31.2	105 Elwood	1,303.7	3.115183
			8 08 45.3	188 08 36.9	108 Twin Hickory	1,971.1	3.294720
103 Idlewild S. Base, 1900 ..... d. m..	42 51 47.49	1,465.4	264 42 23.5	84 42 54.4	104 Gravel	1,036.3	3.015474
	82 28 30.75	698.1	357 27 08.3	177 27 09.3	105 Elwood	743.0	2.870988
			314 00 34.4	134 01 02.8	106 New Calf	1,319.1	3.120262
101 Idlewild N. Base, 1900 ..... d. m..	42 52 06.20	191.3	294 07 45.8	114 08 18.0	104 Gravel	1,178.6	3.071384
	82 28 32.67	741.6	355 39 40.8	175 39 42.1	103 Idlewild S. Base	579.11	2.762760
102 Orchard, 1900 ..... d. m..	42 52 12.65	390.4	8 02 43.0	188 02 40.1	104 Gravel	687.8	2.837493
	82 27 41.05	931.8	80 21 34.1	260 20 59.0	101 N. Base	1,188.7	3.075055
			55 27 35.3	235 27 01.5	103 S. Base	1,369.6	3.136578
Foot of Stag Island, 1900 ..... d. m..	42 52 37.60	1,160.3	337 10 16.2	157 10 25.9	102 Orchard	835.4	2.921876
	82 27 55.33	1,255.8	41 10 50.2	221 10 24.8	101 N. Base	1,287.5	3.109757
Windmill, 1900 ..... d. m..	42 52 34.10	1,052.3	262 26 35.0	82 26 59.5	Foot of Stag Id	823.8	2.915831
	82 28 31.31	710.6	2 03 39.1	182 03 38.2	101 N. Base	861.4	2.935184
			300 06 29.1	120 07 03.3	102 Orchard	1,318.8	3.120175
Terra Cotta, 1900 ..... d. m..	42 52 54.31	1,675.9	301 43 14.9	121 43 39.9	Foot of Stag Id	980.1	2.991258
	82 28 32.06	727.6	358 26 16.7	178 26 17.2	Windmill	623.9	2.795100
Mills, 1900 ..... d. m..	42 53 12.53	386.7	359 54 35.6	179 54 35.7	Foot of Stag Id	1,077.8	3.032524
	82 27 55.40	1,257.2	55 56 30.7	235 56 05.7	Terra Cotta	1,004.2	3.001801
			34 29 43.3	214 29 18.9	Windmill	1,439.0	3.158071
High Point, 1900 ..... d. m..	42 53 51.24	1,581.2	334 26 40.6	154 26 57.7	Mills	1,324.0	3.121877
	82 28 20.57	466.7	8 26 28.8	188 26 21.0	Terra Cotta	1,776.1	3.249470
Head of Stag Id, 1899 ..... d. m..	42 53 43.95	1,356.2	17 29 30.2	197 29 21.0	Mills	1,016.5	3.007094
	82 27 41.94	951.6	104 23 59.9	284 23 33.6	High Point	904.9	2.956616
Shingle, 1899 ..... d. m..	42 54 15.82	488.2	329 29 36.3	149 29 53.7	Head of Stag Id	1,141.5	3.057479
	82 28 07.48	169.7	21 23 10.3	201 23 01.4	High Point	814.6	2.910949
Fromefield, 1899 ..... d. m..	42 54 22.95	708.2	14 42 54.1	194 42 44.6	Head of Stag Id	1,244.2	3.094896
	82 27 28.01	635.5	76 12 18.7	256 11 51.8	Shingle	922.0	2.964723
			50 38 08.1	230 37 32.3	High Point	1,542.5	3.188221

Oak, 1899	d. m.	42 54 50.57	1,560.5	330 59 05.3	150 59 19.5	Fromefield	974.8	2.988929
		82 27 48.85	1,108.1	21 30 19.6	201 30 06.9	Shingle	1,152.6	3.061689
Three Elms, 1899	d. m.	42 54 53.87	1,662.3	12 54 00.2	192 53 53.6	Fromefield	978.7	2.990645
		82 27 18.38	416.9	81 38 59.4	261 38 38.6	Oak	698.6	2.844258
				43 29 59.4	223 29 25.9	Shingle	1,618.2	3.209032
South Bunce, 1889	d. m.	42 55 15.95	492.2	323 56 32.5	143 56 47.4	Three Elms	843.0	2.925801
		82 27 40.26	913.1	13 59 25.1	193 59 19.2	Oak	806.9	2.906822
Poplar, 1899	d. m.	42 55 24.10	743.7	13 14 07.5	193 14 00.9	Three Elms	958.3	2.981496
		82 27 08.70	197.3	70 38 45.0	250 38 23.5	South Bunce	758.4	2.879867
Atkinson, 1899	d. m.	42 55 48.17	1,486.4	326 51 55.4	146 52 10.0	Poplar	886.8	2.947836
		82 27 30.08	682.2	13 04 05.9	193 03 59.0	South Bunce	1,020.4	3.008776
Bridge, 1899	d. m.	42 55 57.98	1,789.1	21 46 13.0	201 46 00.5	Poplar	1,125.8	3.051462
		82 26 50.30	1,140.6	71 26 42.5	251 26 15.4	Atkinson	951.7	2.978481
Sturgis, 1899	d. m.	42 56 13.38	412.9	315 53 45.7	135 53 39.5	Bridge	661.9	2.820786
		82 27 10.61	240.6	29 34 10.3	209 33 57.0	Atkinson	894.7	2.951681
Bush, 1899	d. m.	42 56 17.73	547.1	35 05 27.7	215 05 14.8	Bridge	744.9	2.872095
		82 26 31.41	712.2	81 25 00.4	261 24 33.7	Sturgis	898.9	2.953701
L ttle, 1899	d. m.	42 56 35.62	1,099.2	327 08 58.7	147 09 09.4	Bush	657.0	2.817577
		82 26 47.13	1,068.6	37 48 32.3	217 48 16.3	Sturgis	868.5	2.938762
Dry Dock, 1899	d. m.	42 56 53.94	1,664.5	9 36 48.1	189 36 42.4	Bush	1,133.2	3.054305
		82 26 23.07	523.0	43 59 01.8	223 58 45.4	Little	785.6	2.895226
Elm, 1899		42 56 43.78	1,351.0	47 59 04.7	227 58 37.9	Bush	1,200.9	3.079502
		82 25 52.07	1,180.5	114 02 12.2	294 01 51.1	Dry Dock	769.6	2.886263
Military, 1899	d. m.	42 57 19.09	589.1	3 44 48.8	183 44 46.7	Elm	1,091.9	3.038190
		82 25 48.92	1,108.9	44 55 48.4	224 55 25.1	Dry Dock	1,096.2	3.039906
Indian, 1899	d. m.	42 56 54.57	1,683.9	88 52 59.3	268 52 29.5	Dry Dock	992.5	2.996731
		82 25 39.30	890.6	163 55 27.0	343 55 20.4	Military	787.5	2.896268
Garden, 1899	d. m.	42 57 20.06	619.0	31 44 56.1	211 44 41.5	Indian	925.0	2.966156
		82 25 17.83	404.2	87 34 26.6	267 34 05.4	Military	705.4	2.848437
Beard, 1899	d. m.	42 57 28.33	874.2	294 57 36.1	114 57 52.6	Garden	604.9	2.781711
		82 25 42.02	952.5	28 43 47.0	208 43 42.3	Military	325.2	2.512186
Oil, 1899	d. m.	42 57 34.99	1,079.7	41 37 31.9	221 37 19.6	Garden	616.3	2.789817
		82 24 59.77	1,354.8	77 53 55.1	257 53 26.3	Beard	979.6	2.991039
D. and C. S. Base, 1899	d. m.	42 57 55.99	1,727.7	326 24 06.0	146 24 18.9	Oil	777.8	2.890875
		82 25 18.76	425.2	358 54 46.2	178 54 46.8	Garden	1,108.8	3.044856

TABLE 2.—*Positions, azimuths, and lengths, United States Standard Datum—Triangulation, St. Clair River*—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance, meters.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″			
D. and C. N. Base, 1899 d. m.	42 58 16.99	524.3	347 53 29.9	167 53 38.3	Oil	1,325.3	3.122319
	82 25 12.04	272.9	13 14 08.6	193 14 04.0	D. and C. S. Base	665.63	2.823235
Lumber, 1899	42 57 55.02	1,697.9	92 18 34.4	272 18 12.0	D. and C. S. Base	745.7	2.872572
	82 24 45.88	1,039.8	138 50 32.4	318 50 14.6	D. and C. N. Base	900.5	2.954485
Customs, Canada, 1899 d. m.	42 58 19.67	607.0	54 14 24.5	234 13 54.0	D. and C. S. Base	1,250.3	3.097020
	82 24 33.99	770.3	84 31 04.7	264 30 38.8	D. and C. N. Base	866.1	2.937556
Custom-house, Port Huron, 1899	42 58 29.98	925.2	283 17 46.0	103 18 26.5	Customs, Canada	1,382.4	3.140639
	82 25 33.36	756.0	342 29 21.0	162 29 31.0	D. and C. S. Base	1,099.8	3.041301
			309 40 26.8	129 40 41.4	D. and C. N. Base	627.9	2.797867
Bay Pt., 1889 d. m.	42 59 11.13	343.5	333 32 46.9	153 33 10.7	Customs, Canada	1,773.7	3.248881
	82 25 08.86	200.7	23 36 50.5	203 36 33.8	Custom-house	1,386.0	3.141764
Old Park, 1899 d. m.	42 59 08.35	257.7	9 23 04.6	189 22 57.1	Customs, Canada	1,522.6	3.182579
	82 24 23.03	521.8	94 43 49.8	274 43 18.6	Bay Pt	1,041.7	3.017750
			53 23 20.8	233 22 32.8	Custom-house	1,985.2	3.297812
New Park, 1899 d. m.	42 59 23.81	734.8	340 53 37.2	160 53 42.2	Old Park	505.0	2.703278
	82 24 30.33	687.1	65 51 17.9	245 50 51.6	Bay Pt	956.6	2.980715
Ferry, 1899 d. m.	42 59 29.78	919.0	279 42 34.5	99 43 06.9	New Park	1,090.8	3.037764
	82 25 17.79	403.0	340 37 12.1	160 37 18.2	Bay Pt	610.0	2.785298
			298 03 12.2	118 03 49.9	Old Park	1,405.8	3.147908
Park South Base, 1899 d. m.	42 59 07.54	232.7	201 39 00.1	21 39 08.3	Ferry	738.5	2.868350
	82 25 29.82	675.7	256 50 31.5	76 50 45.8	Bay Pt	487.7	2.688158
Park North Base, 1899 d. m.	42 59 27.73	855.7	263 08 16.2	83 08 32.0	Ferry	529.4	2.723763
	82 25 40.99	928.6	337 53 29.2	157 53 36.8	Park South Base	672.62	2.827769
			305 07 23.5	125 07 45.3	Bay Pt	890.1	2.949454
Queens Hotel, 1899 d. m.	42 59 52.86	1,631.2	318 22 52.4	138 23 16.4	New Park	1,199.1	3.078871
	82 25 05.49	124.4	3 23 41.8	183 23 39.5	Bay Pt	1,290.1	3.110624
			21 22 14.1	201 22 05.7	Ferry	765.0	2.883682
			46 02 34.0	226 02 09.9	Park North Base	1,117.4	3.048220
Wye, 1899 d. m.	42 59 38.83	1,198.3	242 23 17.9	62 23 42.8	Queens Hotel	934.0	2.970370
	82 25 42.03	952.2	318 41 12.9	138 41 35.5	Bay Pt	1,138.2	3.056229
Block I, 1900 d. m.	43 00 11.31	349.0	326 58 04.7	146 58 15.8	Queens Hotel	679.2	2.832011
	82 25 21.84	494.7	24 31 55.7	204 31 41.9	Wye	1,101.7	3.042082

New Center Range, 1900 .... d. m.	43 00 10.03 82 25 02.60	309.5 58.9	7 02 53.8 95 10 54.8	187 02 51.8 275 10 41.7	Queens Hotel Block I	534.0 437.5	2.727524 2.641001
Fort Gratiot Lt. H. Station, 1900 .... d. m.	43 00 23.32 82 25 20.81	719.6 471.3	314 50 34.4 3 36 01.4 339 44 40.6	134 50 46.8 183 36 00.7 159 44 51.0	New Center Range Block I Queens Hotel	581.6 371.4 1,002.1	2.764661 2.569844 3.000900
Fort Gratiot Light-house, 1900	43 00 22.44 82 25 21.42	692.5 485.2	283 35 07.0 338 25 36.9	103 35 40.5 158 25 47.8	Sand Queens Hotel	1,145.1 981.5	3.058850 2.991895
Sand, 1900 .... d. m.	43 00 13.72 82 24 32.28	423.4 731.2	49 27 00.5 86 13 12.5	229 26 37.8 266 12 38.7	Queens Hotel Block I	990.1 1,124.9	2.995666 3.051113
New Bluff, 1900 .... d. m.	43 00 30.39 82 25 25.17	937.8 570.1	293 13 50.4 338 56 52.4	113 14 26.5 158 57 05.8	Sand Queens Hotel	1,303.6 1,240.8	3.115138 3.093694
Pine, 1899 .... d. m.	43 00 48.88 82 25 30.39	1,508.4 688.2	309 30 10.9 348 18 23.8	129 30 50.5 168 18 27.4	Sand New Bluff	1,705.6 582.9	3.231883 2.765610

TABLE 3.—*Dry-dock section St. Clair River.*

[Areas of sections and velocity of factors.]

Section and station.	Area square feet for 578.00 D. D. gauge.	Factor 0.3 depth.	Factor 0.5 depth.	Factor 0.7 depth.
1	1,099	0.876	0.928	1.048
2	2,088	.901	.930	1.020
3	2,369	.904	.974	1.060
4	2,480	.927	.964	1.031
5	2,461	.913	.956	1.036
6	2,475	.913	.956	1.036
7	2,472	.913	.956	1.036
8	2,503	.898	.944	1.055
9	3,189	.913	.956	1.036
10	3,451	.927	.964	1.031
11	3,440	.927	.964	1.031
12	3,413	.927	.964	1.031
13	3,390	.927	.964	1.031
14	3,330	.927	.964	1.031
15	3,272	.927	.964	1.031
16	3,338	.913	.956	1.036
17	3,424	.913	.956	1.036
18	3,472	.913	.954	1.034
19	3,208	.913	.956	1.036
20	2,813	.907	.956	1.036
21	1,558	.882	.940	1.060

TABLE 4.—*Measurements of discharge, St. Clair River, dry dock section, 1902.*

Date.	Time.		Water surface above mean tide, New York.						Wind, direction and miles per hour.	Range at G. T. R. gauge.	Discharge in 100 cubic feet per second, as given by meter.				Mean discharge.
	From—	To—	Lexington.	G. T. R.	M. B. R.	Dry dock.	Roberts Landing.	St. Clair Flats.			14 B at 0.5 depth.	8 B at 0.3 depth.	14 B at 0.5 depth.	8 B at 0.7 depth.	
1902.	h. m.	h. m.								Feet.					
Aug. 12	9 18	15 55	580.91	579.666	579.181	578.777	576.32	575.60	NE., 11	0.14	1,972	1,995	1,981	2,034	1,995
13	8 21	17 00	580.76	579.528	579.053	578.665	576.28	575.60	SE., 8	.15	1,917	1,955	1,941	1,963	1,944
14	7 53	11 46	580.81	579.554	579.080	578.679	576.22	575.55	NE., 6	.18	1,958	1,992	1,955	1,991	1,974
15	7 51	11 59	580.89	579.660	579.165	578.766	576.27	575.55	N., 6	.26	2,007	2,054	1,961	2,026	2,012
16	7 53	13 35	580.82	579.643	579.120	578.690	576.21	575.45	NE., 13	.18	1,981	2,026	1,975	2,033	2,004
18	8 01	12 01	580.75	579.480	579.046	578.639	576.22	575.45	SW., 9	.25	1,912	1,958	1,903	1,956	1,932
18	12 58	16 41	580.72	579.516	578.996	578.592	576.17	575.45	SW., 11	.20	1,891	1,945	1,910	1,943	1,922
19	7 55	11 37	580.74	579.519	579.010	578.627	576.19	575.40	N., 12	.20	1,967	2,001	1,924	1,948	1,960
19	12 36	16 24	580.80	579.586	579.074	578.709	576.21	575.40	NE., 13	.27	1,998	2,070	1,968	2,035	2,018
20	8 00	13 35	580.79	579.532	579.038	578.702	576.19	575.40	SE., 6	.43	1,951	1,994	1,926	1,971	1,960
21	7 54	11 39	580.87	579.656	579.123	578.768	576.23	575.40	NE., 12	.15	1,996	2,034	2,010	2,039	2,020
21	12 48	16 46	580.92	579.702	579.180	578.802	576.28	575.40	NE., 12	.13	1,986	2,019	2,022	2,035	2,015
22	7 49	14 35	580.99	579.768	579.233	578.875	576.26	575.40	NW., 16	.31	2,077	2,072	2,056	2,094	2,075
25	8 44	14 12	580.73	579.459	578.936	578.620	......	575.40	N., 6	.14	1,945	1,941	1,933	1,943	1,940
26	7 47	13 43	580.68	579.446	......	578.603	576.16	575.30	W., 7	.24	1,915	1,921	1,921	1,947	1,926
26	13 15	16 49	580.78	a[579.55]	......	578.649	576.18	575.30	W., 14	......	1,949	1,970	1,921	1,953	1,948
27	7 54	11 40	580.80	579.558	579.036	578.651	576.13	575.35	N., 9	.16	1,975	1,975	1,991	1,980	1,980
28	11 10	16 28	580.70	579.501	579.000	578.593	576.14	575.30	NE., 14	.16	1,977	1,950	1,962	1,979	1,967
Sept. 2	8 34	14 54	580.75	a[579.52]	578.960	578.599	576.10	575.30	N., 9	......	1,973	1,958	1,980	1,984	1,974
3	7 54	14 31	580.37	a[579.14]	578.674	578.324	576.10	575.20	SW., 17	......	1,771	1,773	1,757	1,762	1,766
4	7 49	12 10	581.15	a[579.92]	579.458	579.047	576.25	575.20	NW., 20	......	2,121	2,145	2,132	2,142	2,135
4	12 00	16 46	580.95	a[579.72]	579.234	578.837	576.20	575.20	NW., 22	......	2,050	2,079	2,108	2,149	2,096
5	7 49	11 47	580.68	a[579.45]	578.906	578.550	576.03	575.20	W., 7	......	1,956	1,977	1,935	1,947	1,954
5	12 45	15 47	580.60	a[579.37]	578.840	578.490	576.04	575.20	NE., 6	......	1,898	1,925	1,954	2,004	1,945
6	7 55	11 51	580.01	a[578.78]	578.431	578.088	575.99	575.20	SW., 15	......	1,703	1,707	1,699	1,719	1,707
6	12 35	16 15	580.42	a[579.19]	578.754	578.404	576.03	575.20	SW., 12	......	1,840	1,856	1,829	1,836	1,840
8	8 01	11 57	580.33	a[579.10]	578.582	578.263	575.92	575.20	SW., 12	......	1,838	1,844	1,830	1,848	1,840
8	12 48	16 39	580.31	579.018	578.497	578.193	575.91	575.20	SW., 20	0.28	1,757	1,780	1,769	1,764	1,767
10	9 01	14 45	580.55	a[579.32]	578.818	578.447	576.02	575.20	SW., 15	......	1,862	1,834	1,851	1,847	1,848
11	8 00	12 03	580.56	a[579.33]	578.839	578.446	576.02	575.18	SW., 12	......	1,907	1,838	1,939	1,919	1,901
12	7 53	14 04	580.66	a[579.43]	578.880	578.536	575.98	575.10	SW., 4	......	1,940	1,944	1,954	1,962	1,959
13	8 37	13 11	580.54	a[579.31]	578.862	578.480	576.06	575.20	W., 15	......	1,851	1,873	1,858	1,899	1,870
15	7 52	11 26	580.51	579.216	578.798	578.406	576.04	575.20	SW., 13	.08	1,807	1,796	1,835	1,846	1,821
15	11 28	15 42	580.45	579.174	578.750	578.352	575.99	575.20	SW., 15	.15	1,760	1,770	1,785	1,802	1,779
16	7 45	11 30	580.42	579.152	578.753	578.372	575.89	575.10	S., 6	.15	1,853	1,852	1,869	1,887	1,865
16	11 31	15 28	580.43	a[579.20]	578.726	578.332	575.88	575.10	S., 12	......	1,789	1,789	1,817	1,797	1,798
17	7 48	10 38	580.30	579.048	578.620	578.200	575.88	575.10	SE., 7	.20	1,789	1,787	1,790	1,795	1,790
17	10 40	15 26	580.25	579.066	578.639	578.222	575.88	575.10	S., 10	.13	1,803	1,807	1,818	1,839	1,817
18	7 47	13 18	580.42	a[579.19]	578.720	578.316	575.85	575.10	S., 9	......	1,832	1,845	1,824	1,840	1,835

a G. T. R. readings in brackets are derived from Lexington readings by subtracting 1.23 feet.

TABLE 4.—*Measurements of discharge, St. Clair River, dry dock section, 1902*– Continued.

Date.	Time.		Water surface above mean tide, New York.						Wind, direction and miles per hour.	Range at G. T. R. gauge.	Discharge in 100 cubic feet per second, as given by meter.				Mean discharge.
	From—	To—	Lexington.	G. T. R.	M. B. R.	Dry dock.	Roberts Landing.	St. Clair Flats.			14 B at 0.5 depth.	8 B at 0.3 depth.	14 B at 0.5 depth.	8 B at 0.7 depth.	
1902.	*h. m.*	*h. m.*								*Feet.*					
Sept. 19	7 51	11 41	580.60	579.440	578.957	578.525	575.97	575.15	N., 12	0.15	1,951	1,936	1,947	1,959	1,948
20	8 20	12 05	580.58	579.300	578.818	578.413	575.97	575.15	SE., 3	.18	1,909	1,861	1,888	1,861	1,880
22	7 51	11 33	580.42	579.207	578.729	578.342	575.91	575.10	SW., 4	.17	1,864	1,840	1,907	1,902	1,878
22	11 35	16 02	580.48	579.203	578.746	578.364	575.92	575.10	SW., 4	.20	1,850	1,824	1,849	1,841	1,841
23	7 45	11 16	580.52	579.252	578.748	578.359	575.92	575.15	N., 5	.16	1,888	1,858	1,889	1,882	1,879
23	11 18	15 35	580.56	579.336	578.829	578.450	575.97	575.15	N., 12	.14	1,917	1,880	1,910	1,919	1,906
24	7 54	11 59	580.49	579.268	578.755	578.374		575.15	E., 20	.35	1,879	1,868	1,939	1,947	1,908
25	7 52	13 18	580.20	579.034	578.550	578.242		575.30	E., 10	.14	1,824	1,767	1,811	1,766	1,792
26	8 35	14 00	580.31	579.174	578.686	578.314	576.08	575.40	S., 6	.16	1,845	1,788	1,856	1,816	1,827

REPORT OF MR. MURRAY BLANCHARD, JUNIOR ENGINEER.

UNITED STATES LAKE SURVEY OFEICE,
Detroit, Mich., June 30, 1903.

MAJOR: I have the honor to submit the following report on the discharge measurements of the Detroit and St. Clair rivers, under my charge during the past year.

At times when the discharge work could not be carried on, stadia surveys were made along the river fronts of Detroit and Windsor, where recent changes have occurred.

The field work was commenced on the Detroit River at section Fort Wayne (Detroit) one week before the beginning of the fiscal year, and four discharges not included in the summary of the last annual report were measured in June, 1902. The discharge measurements of Detroit River were continued until August 8, when the party, with the discharge outfit, including tug *U. S. L. S. No. 2* and one catamaran, was taken to Port Huron. The next six weeks were devoted to the gauging of St. Clair River on section Dry Dock, at Port Huron. The section was re-sounded. Three stations were selected for vertical curve observations to determine whether there had been any change in the curve since the multiple meter observations of 1899, and about 30 curves were measured on each of the three stations. Forty-eight discharges were measured, the notes of which were turned over to Asst. Engineer L. C. Sabin for reduction.

Before returning to Detroit a survey was made on a portion of the shoal at the mouth of Black River where the steamer *City of Rome* grounded. This survey was platted and has been reported.

On returning to Detroit October 1 the discharge measurements were resumed and continued until the 20th of November, when the field work was closed.

Discharge of Detroit River.—The discharge section at Fort Wayne was sounded at the beginning of the season with a 70-pound "fish" weight suspended on a No. 9 galvanized wire. The heavy weight made the deflection of the sounding wire from the vertical considerably less than in the 1901 soundings. It appears that too large a deflection correction was applied to the soundings in 1901, so that a recomputation of the area for that year has been made by applying the corrections given in Table No. 1, found on page 5330, Appendix III, Report of the Chief of Engineers, United States Army, for 1900. This table, computed by Asst. Engineer F. C. Shenehon, has been tested on soundings made in the swift current of the Niagara River with various deflections. The close agreement of the two seasons' determinations of the partial areas on section Fort Wayne indicates that no scour has taken place, and the discrepancy in the total areas has been attributed to errors of observation. The mean of the two determinations of the area has been used in computing all of the discharges summarized in this report, which accounts for the disagreement with the volumes of discharge summarized in the last report. The two area measurements and the mean value used are given in Table No. 1.

The meters were rated about once a month, and a rate comparison, whenever the meters were used, was made by running them side by side on the section at the same depth. The rating equations of the meters and their application are given in Table No. 2. A comparison of all the ratings made in 1901 and 1902 is shown in Tables Nos. 3 and 4.

Stations Nos. 4, 9, 15, and 20 were selected for vertical curve observations, and about 20 curves were measured at each station. A comparison with the 1901 multiple meter curves is shown on Plates Nos. 1 to 4. The coefficients at the 0.3, 0.5, and 0.7 depths are those used in the discharge computations. The mean of the discharges at these depths is used as one discharge, and the means of the three coefficients for each station agree closely for the two years, except for the shallow station No. 20, where the curve is abnormal and varies. The discrepancy on this station in the two years, although amounting to 2 per cent, would not affect the partial discharge more than 60 cubic feet per second, or 0.0003 of the average total discharge. Therefore the multiple meter coefficients have been used for both seasons.

In the two seasons 117 discharges have been measured, with a range of 1.6 feet in the Windmill Point or Lake St. Clair stage, of 2.5 feet in the Amherstburg or Lake Erie stage, and of 50,000 cubic feet per second in the discharge. Some of the observations were made when the river was rough and the wind strong, because such conditions are generally found with extreme stages and accompany a very high or low discharge. In such cases, however, there is generally a large fluctuation in the stage of Lake Erie and an uncertainty as to the effective stage of that lake.

In Table No. 6 the results of the discharge measurements for 1901 and 1902 are given, with the corresponding gauge readings at Windmill Point, Fort Wayne section, and Amherstburg.

Very respectfully, your obedient servant,

MURRAY BLANCHARD,
Junior Engineer.

Maj. W. L. FISK,
Corps of Engineers, U. S. Army.

TABLE 1.—*Area measurements, 1901 and 1902.*

Station.	Area for stage 574.4.			Station.	Area for stage 574.4.		
	1901.	1902.	Mean used.		1901.	1902.	Mean used.
1	822	773	798	13	3,862	3,912	3,887
2	3,090	3,024	3,057	14	4,022	4,068	4,045
3	3,760	3,761	3,760	15	4,117	4,161	4,139
4	4,021	4,019	4,020	16	4,107	4,131	4,119
5	4,421	4,435	4,428	17	4,138	4,190	4,164
6	4,571	4,591	4,581	18	3,959	3,961	3,960
7	4,582	4,623	4,602	19	3,624	3,555	3,590
8	4,648	4,640	4,644	20	1,742	1,717	1,729
9	4,474	4,490	4,482	21	383	385	384
10	4,285	4,294	4,290				
11	4,154	4,182	4,168	Total	76,692	76,848	76,770
12	3,910	3,936	3,923				

TABLE 2.—*Rating equations of the meters used in 1902.*

Meter No.	Date of rating.	No. of observations.	Equations.	Limiting values of x.	Discharge measurements to which applied.	
					Numbers.	Dates, 1902.
	1991.					
11 B	Nov. 21	22	$y=1.093x+0.261$	0.00–1.33	47– 67	June 25 to July 10.
			$y=1.220x+0.137$	1.33–5.00	47– 67	Do.
	1992.					
10 B	July 16	22	$y=1.164x+0.230$	0.00–2.48	68– 78	July 11 to July 25.
			$y=1.267x+0.031$	2.48–5.00	68– 78	Do.
8 B	July 16–17	30	$y=1.263x+0.044$	1.32–5.00	57– 88	June 25 to Aug. 6.
	Aug. 23	18	$y=1.269x+0.065$	1.09–4.00		Aug. and Sept., Port Huron.
	Oct. 3–4	27	$y=1.286x+0.354$	1.00–5.00	89– 94	Oct. 7 to Oct. 16.
	Nov. 6–7	25	$y=1.265x+0.046$	1.24–5.00	94–117	Oct. 16 to Nov. 20.
14 B	July 17	16	$y=1.178x+0.147$	1.50–5.00	79– 88	July 26 to Aug. 6.
	Aug. 23	10	$y=1.208x+0.096$	0.00–5.00		Aug. and Sept., Port Huron.
	Oct. 3–4	27	$y=1.105x+0.328$	0.00–2.20	89– 94	Oct. 7 to Oct. 16.
			$y=1.167x+0.224$	2.20–5.00	89– 94	Do.
	Nov. 6–7	29	$y=1.177x+0.126$	0.00–1.79	94–117	Oct. 16 to Nov. 20.
			$y=1.225x+0.058$	1.79–5.00	94–117	Do.

TABLE 3.—*Summary of rating of discharge meters.*

Meter.	Date.	Place.	Absolute rating. Revolutions per second.						Relative rating. Revolutions per second.					
			1.0.	1.5.	2.0.	2.5.	3.0.	3.5.	1.0.	1.5.	2.0.	2.5.	3.0.	3.5.
			V=Velocity per second.						Percentage velocity.					
	1901.													
11 B	June 5	Port Huron	1.36	1.94	2.55	3.18	3.80	4.43	0.36	0.51	0.67	0.84	1.00	1.17
	Aug. 6	Detroit	1.39	1.95	2.54	3.14	3.73	4.32	.37	.52	.68	.84	1.00	1.16
	Nov. 19-21	do	1.35	1.96	2.58	3.19	3.80	4.41	.36	.52	.68	.84	1.00	1.16
5 A[a]	June 5	Port Huron	1.39	2.00	2.62	3.24	3.86	4.48	.36	.52	.68	.84	1.00	1.16
	Aug. 6	Detroit	1.36	1.99	2.62	3.25	3.88	4.50	.35	.51	.68	.84	1.00	1.16
5 A[b]	Aug. 6	do	1.45	2.06	2.68	3.29	3.90	4.51	.37	.53	.69	.84	1.00	1.16
	Nov. 19-21	do	1.44	2.06	2.69	3.32	3.96	4.59	.36	.52	.68	.84	1.00	1.16
8 B	Aug. 10	do	1.38	1.93	2.53	3.18	3.83	4.48	.36	.50	.66	.83	1.00	1.17
	Aug. 12	do	1.36	1.99	2.62	3.25	3.88	4.51	.35	.51	.68	.84	1.00	1.16
	1902.													
	July 16-17	do	1.31	1.94	2.57	3.20	3.83	4.46	.34	.51	.67	.84	1.00	1.16
	Aug. 23	Port Huron	1.34	1.97	2.60	3.24	3.87	4.51	.35	.51	.67	.84	1.00	1.17
	Oct. 3-4	Detroit	1.33	1.96	2.61	3.25	3.89	4.54	.34	.50	.67	.84	1.00	1.17
	Nov. 6-7	do	1.31	1.94	2.58	3.21	3.84	4.47	.34	.50	.67	.84	1.00	1.16
14 B	July 17	do	1.33	1.91	2.50	3.09	3.68	4.27	.36	.52	.68	.84	1.00	1.16
	Aug. 23	Port Huron	1.30	1.91	2.51	3.12	3.72	4.32	.35	.51	.68	.84	1.00	1.16
	Oct. 3-4	Detroit	1.43	1.98	2.56	3.14	3.72	4.31	.38	.53	.69	.84	1.00	1.16
	Nov. 6-7	do	1.30	1.90	2.51	3.12	3.73	4.34	.35	.51	.67	.84	1.00	1.16

[a] Head No. 2. [b] Head No. 5.

TABLE 4.—*Summary of rating of multiple meter set at Detroit.*

Meter.	Date.	Absolute rating. Revolutions per second.						Relative rating. Revolutions per second.					
		1.0.	1.5.	2.0.	2.5.	3.0.	3.5.	1.0.	1.5.	2.0.	2.5.	3.0.	3.5.
		V=Velocity per second.						Percentage velocity.					
	1901.												
13 B	August 8-9	1.29	1.89	2.48	3.08	3.68	4.27	0.35	0.51	0.67	0.84	1.00	1.16
	November 19-21	1.35	1.88	2.49	3.09	3.69	4.30	.37	.51	.68	.84	1.00	1.17
7 A	August 8-9	1.33	1.92	2.51	3,10	3.69	4.28	.36	.52	.68	.84	1.00	1.16
	November 19-21	1.36	1.92	2.53	3.14	3.75	4.36	.36	.51	.68	.84	1.00	1.16
10 B	August 8-9	1.42	1.99	2.61	3.22	3.83	4.44	.37	.52	.68	.84	1.00	1.16
	November 19-21	1.33	1.94	2.55	3.17	3.80	4.43	.35	.51	.67	.83	1.00	1.17
14 B	August 8-9	1.33	1.89	2.46	3.05	3.64	4.22	.37	.52	.68	.84	1.00	1.16
	November 19-21	1.27	1.86	2.45	3.05	3.64	4.23	.35	.51	.67	.84	1.00	1.16
12 B	August 8-9	1.32	1.88	2.51	3.13	3.76	4.39	.35	.50	.67	.83	1.00	1.17
	November 19-21	1.37	1.90	2.50	3.10	3.71	4.31	.37	.51	.67	.84	1.00	1.16
15 B	August 8-9	1.33	1.95	2.57	3.23	3.88	4.54	.34	.50	.66	.83	1.00	1.17
	November 19-21	1.33	1.94	2.56	3.19	3.82	4.45	.35	.51	.67	.84	1.00	1.17
11 B	August 8-9	1.33	1.91	2.51	3.15	3.79	4.42	.35	.50	.66	.83	1.00	1.17
	November 19-21	1.32	1.90	2.54	3.17	3.80	4.44	.35	.50	.67	.83	1.00	1.17
8 B	August 8-9	1.36	1.91	2.54	3.17	3.79	4.42	.36	.50	.67	.84	1.00	1.17
	November 19-21	1.35	1.95	2.54	3.18	3.82	4.46	.35	.51	.67	.83	1.00	1.17
6 A	August 8-9	1.36	1.99	2.63	3.26	3.90	4.53	.35	.51	.67	.84	1.00	1.16
	do	1.40	2.00	2.64	3.28	3.93	4.57	.36	.51	.67	.84	1.00	1.16
	November 19-21	1.34	1.94	2.55	3.20	3.84	4.49	.35	.51	.66	.83	1.00	1.17

TABLE NO. 5.—*Comparison of 1901 and 1902 coefficients at tenths of depth.*

Station.	Year.	Method.	No. of obs.	0.3.	0.5.	0.7.	Mean of 0.3, 0.5, and 0.7.
4	1901	Multiple meter	20	0.912	0.970	1.061	0.981
	1902	Two meter	17	.923	.972	1.036	.977
9	1901	Multiple meter	45	.907	.967	1.050	.975
	1902	Two meter	20	.907	.969	1.066	.981
15	1901	Multiple meter	23	.906	.959	1.049	.971
	1902	Two meter	20	.915	.958	1.035	.969
20	1901	Multiple meter	20	.982	.957	.969	.969
	1902	Two meter	21	.985	.989	1.009	.994

TABLE 6.—*Summary of measurements of discharge. Detroit River, 1901–2.*

Number of measurement.	Date of observation.	Wind (average).		Water surface—570 feet above mean tide at New York.			Fall.		Depth ratio.		Discharge observed.
		Direction from which blows.	Velocity (miles per hour).	Windmill Point. A.	Fort Wayne. B.	Amherstburg. C.	A−B.	A−C.	First.	Second.	
	1901.										*cu. ft. sec.*
1	July 19	E.	7	4 97	4.11	1.99	0.86	2.98	0.3, 0.5	0.5, 0.7	207,500
2	July 20	SW.	13	4.93	4.05	1.91	.88	3.02	.3, .5	.5, .7	201,770
3	July 22	NE.	13	5.00	4.11	1.90	.89	3.10	.3, .5	.5, .7	210,340
4	July 23	E.	10	4.95	4.11	2.03	.84	2.92	.3, .5	.5, .7	203,540
5	July 25	SSW.	6	5.00	4.18	2.14	.82	2.86	.3, .5	.5, .7	207,020
6	July 26	ENE.	10	5.02	4.26	2.38	.76	2.64	.3, .5	.5, .7	198,740
7	July 27	S.	14	5.08	4.26	2.08	.82	3.00	.3, .5	.5, .7	207,660
8	July 30	W.	18	4.92	3.98	1.55	.94	3.37	.3, .5	.5, .7	211,900
9	July 31	NW.	14	4.97	4.14	2.09	.83	2.88	.3, .5	.5, .7	203,730
10	Aug. 1	NE.	8	5.03	4.15	1.87	.88	3.16	.3, .5	.5, .7	217,240
11	Aug. 3	NNW.	9	5.05	4.25	2.13	.80	2.92	.3, .5	.5, .7	195,410
12	Aug. 15	SW.	10	4.84	4.00	1.68	.84	3.16	.3, .5	.5, .7	201,[illegible]40
13	....do....	W.	13	4.84	3.97	1.59	.87	3.25	.3, .5	.5, .7	204,130
14	Aug. 16	ENE.	8	4.93	4.15	1.98	.77	2.95	.3, .5	.5, .7	198,680
15	....do....	E.	8	4.90	4.06	1.64	.84	3.26	.3, .5	.5, .7	208,200
16	Aug. 17	ESE.	10	4.94	4.19	2.13	.75	2.81	.3, .5	.5, .7	200,500
17	....do....	ESE.	8	4.94	4.15	1.96	.79	2.98	.3, .5	.5, .7	199,370
18	Aug. 19	S.	10	4.94	4.16	2.05	.78	2.89	.3, .5	.5, .7	199,100
19	....do....	SW.	9	4.94	4.12	1.84	.82	3.10	.3, .5	.5, .7	204,330
20	Aug. 20	NE.	10	4.96	4.13	1.98	.83	2.98	.3, .5	.5, .7	207,300
21	....do....	E.	10	5.00	4.19	2.08	.81	2.92	.3, .5	.5, .7	205,800
22	Aug. 21	SW.	10	4.96	4.15	2.05	.81	2.91	.3, .5	.5, .7	200,040
23	Aug. 29	SW.	10	4.93	4.09	1.89	.84	3.04	.3, .5	.5, .7	203,740
24	....do....	SW.	10	4.93	4.09	1.87	.84	3.06	.3, .5	.5, .7	202,620
25	Aug. 30	NW.	7	4.88	4.09	1.97	.79	2.91	.3, .5	.5, .7	193,990
26	....do....	SSE.	4	4.96	4.14	1.90	.82	3.06	.3, .5	.5, .7	200,450
27	Aug. 31	N.	14	4.99	4.12	1.94	.87	3.05	.3, .5	.5, .7	205,210
28	....do....	N.	14	4.98	4.08	1.70	.90	3.28	.3, .5	.5, .7	214,600
29	Sept. 3	N.	7	5.01	4.17	2.01	.84	3.00	.3, .5	.5, .7	202,420
30	....do....	N.	7	5.00	4.13	1.82	.87	3.18	.3, .5	.5, .7	205,980
31	Sept. 4	NW.	6	4.99	4.17	2.03	.82	2.96	.3, .5	.5, .7	202,570
32	....do....	W.	7	5.01	4.19	1.96	.82	3.05	.3, .5	.5, .7	204,390
33	Sept. 5	WSW.	7	4.99	4.14	1.89	.85	3.10	.3, .5	.5, .7	208,200
34	....do....	SW.	7	5.00	4.21	2.11	.79	2.89	.3, .5	.5, .7	199,890
35	Sept. 7	W.	7	4.96	4.13	1.93	.83	3.03	.3, .5	.5, .7	207,340
36	....do....	WSW.	10	5.00	4.16	1.98	.84	3.02	.3, .5	.5, .7	203,210
37	Sept. 17	W.	17	4.61	3.82	1.72	.79	2.89	.3, .5	.5, .7	190,710
38	Sept. 24	NE.	14	4.77	3.92	1.76	.85	3.01	.3, .5	.5, .7	206,350
39	Oct. 7	SSW.	8	4.63	3.82	1.66	.83	2.97	.3, .5	.5, .7	193,460
40	Oct. 8	SSW.	17	4.52	3.67	1.36	.85	3.16	.3, .5	.5, .7	193,590
41	Oct. 10	W.	12	4.49	3.61	1.28	.88	3.21	.3, .5	.5, .7	198,250
42	....do....	WNW.	7	4.51	3.61	1.28	.90	3.23	.3, .5	.5, .7	202,700
43	Oct. 11	S.	18	4.51	3.68	1.51	.83	3.00	.3, .5	.5, .7	192,460
44	Oct. 12	S.	15	4.57	3.74	1.67	.83	2.90	.3, .5	.5, .7	190,090
45	Oct. 16	NW.	4	4.59	3.78	1.56	.81	3.03	.3, .5	.5, .7	194,470
46	Oct. 17	NW.	16	4.24	3.30	.85	.94	3.39	.3, .5	.5, .7	198,760
47	Oct. 19	NNW.	12	4.44	3.45	.77	.99	3.67	.3, .5	.5, .7	216,480
48	Oct. 21	SW.	12	4.42	3.51	1.06	.91	3.36	.3, .5	.5, .7	201,270
49	....do....	SW.	12	4.47	3.62	1.41	.85	3.06	.3, .5	.5, .7	197,300
50	Oct. 31	SW.	21	4.30	3.50	1.45	.80	2.85	.3, .5	.5, .7	183,600
51	Nov. 29	NW.	10	4.16	3.25	1.13	.91	3.03	.3, .5	.5, .7	197,290
52	Nov. 30	SSW.	10	4.22	3.31	1.08	.91	3.14	.3, .5	.5, .7	195,040
53	Dec. 2	N.	10	4.15	3.25	1.10	.90	3.05	.3, .5	.5, .7	192,980
54	Dec. 3	NNE.	17	4.31	3.45	1.46	.86	2.85	.3, .5	.5, .7	199,220
55	Dec. 4	NW.	9	4.21	3.19	1.05	1.02	3.16	.3, .5	.5, .7	198,690
56	Dec. 10	SW.	16	4.00	3.14	1.10	.86	2.90	.3, .5	.5, .7	178,600
	1902.										
57	June 25	S.	19	4.74	4.29	2.66	.45	2.08	.3, .5	.5, .7	166,500
58	June 26	W.	19	4.84	3.84	1.81	1.00	3.03	.3, .5	.5, .7	184,100
59	June 27	N.	4	4.76	4.05	2.10	.71	2.66	.3, .5	.5, .7	209,540
60	June 28	E.	7	4.88	4.17	2.11	.71	2.77	.3, .5	.5, .7	199,450
61	July 1	W.	7	5.09	4.35	2.30	.74	2.79	.3, .5	.5, .7	200,800
62	July 3	W.	16	5.28	4.45	2.43	.83	2.85	.3, .5	.5, .7	205,420
63	July 5	WSW.	16	5.59	4.72	2.54	.87	3.05	.3, .5	.5, .7	219,480
64	July 7	SW.	12	5.44	4.70	2.68	.74	2.76	.5, .3	.3, .7	208,460
65	July 8	WSW.	6	5.43	4.70	2.70	.73	2.73	.5, .3	.3, .7	206,540
66	July 9	WSW.	12	5.36	4.62	2.65	.74	2.71	.5, .3	.3, .7	206,500
67	July 10	NNE.	13	5.45	4.71	2.82	.74	2.63	.5, .3	.3, .7	215,290
68	July 11	SW.	7	5.39	4.68	2.90	.71	2.49	.5, .3	.3, .7	198,920
69	July 12	W.	8	5.36	4.65	2.82	.71	2.54	.5, .3	.3, .7	198,320
70	July 14	WSW.	9	5.27	4.59	2.80	.68	2.47	.5, .3	.3, .7	199,280
71	July 15	NW.	14	5.27	4.37	2.32	.90	2.95	.5, .3	.3, .7	211,880
72	July 18	E.	7	5.34	4.59	2.67	.75	2.67	.5, .3	.3, .7	200,730

TABLE 6.—*Summary of measurements of discharge, Detroit River, 1901-2*—Cont'd.

Number of measurement.	Date of observation.	Wind (average).		Water surface—570 feet above mean tide at New York.			Fall.		Depth ratio.		Discharge observed.
		Direction from which blows.	Velocity (miles per hour).	Windmill Point. A.	Fort Wayne. B.	Amherstburg. C.	A—B.	A—C.	First.	Second.	
	1902.										*Cu. ft. sec.*
73	July 19	SW.	15	5.25	4.62	2.99	.63	2.26	.5, .3	.3, .7	170,520
74	July 21	NW.	13	5.48	4.61	2.51	.87	2.97	.5, .3	.3, .7	211,180
75	July 22	NW.	8	5.61	4.81	2.96	.80	2.65	.5, .3	.3, .7	208,300
76	July 23	WSW.	12	5.52	4.74	2.80	.78	2.72	.5, .3	.3, .7	203,550
77	July 24	SW.	8	5.55	4.85	3.02	.70	2.53	.5, .3	.3, .7	200,600
78	July 25	SE.	7	5.54	4.90	3.11	.64	2.43	.5, .3	.3, .7	206,800
79	July 26	SW.	11	5.51	4.81	2.95	.70	2.56	.5, .3	.3, .7	204,860
80	July 28	E.	5	5.54	4.84	2.90	.68	2.64	.5, .3	.3, .7	209,720
81	July 29	NE.	9	5.63	4.90	3.14	.73	2.49	.5, .3	.3, .7	204,900
82	July 30	E.	8	5.56	4.89	3.06	.67	2.50	.5, .3	.3, .7	205,240
83	July 31	SW.	7	5.59	4.82	2.98	.77	2.61	.5, .3	.3, .7	206,350
84	Aug. 1	N.	10	5.62	4.84	2.96	.78	2.66	.5, .3	.3, .7	209,940
85	Aug. 2	SE.	6	5.56	4.80	2.95	.76	2.61	.5, .3	.3, .7	202,900
86	Aug. 4	NW.	7	5.46	4.77	2.90	.69	2.56	.5, .3	.3, .7	199,560
87	Aug. 5	SW.	13	5.40	4.68	2.97	.72	2.43	.5, .3	.3, .7	190,000
88	Aug. 6	N.	10	5.43	4.70	2.70	.73	2.73	.5, .3	.3, .7	191,860
89	Oct. 7	WNW.	10	4.99	4.27	2.62	.72	2.37	.5, .3	.3, .7	188,520
90	Oct. 8	SW.	17	4.82	4.07	2.12	.75	2.70	.5, .3	.3, .7	180,140
91	Oct. 9	NE.	15	5.19	4.57	3.31	.62	1.88	.5, .3	.3, .7	186,820
92	Oct. 14	WNW.	14	4.63	3.80	1.82	.83	2.81	.5, .3	.3, .7	198,880
93	Oct. 16	NNE.	14	4.79	4.25	2.86	.54	1.93	.5, .3	.3, .7	184,390
94	...do....	NE.	12	4.85	4.12	2.17	.73	2.68	.5, .3	.3, .7	201,360
95	Oct. 17	ENE.	11	4.91	4.14	2.37	.77	2.54	.5, .3	.3, .7	191,830
96	Oct. 18	SW.	12	4.76	4.05	2.25	.71	2.51	.5, .3	.3, .7	183,010
97	Oct. 20	W.	10	4.72	4.00	2.15	.72	2.57	.5, .3	.3, .7	193,680
98	Oct. 21	NE.	9	4.80	4.09	2.38	.71	2.42	.5, .3	.3, .7	195,530
99	Oct. 22	SSE.	7	4.74	4.05	2.30	.69	2.44	.5, .3	.3, .7	195,380
100	Oct. 23	ENE.	12	4.87	4.19	2.66	.68	2.21	.5, .3	.3, .7	188,520
101	Oct. 24	SW.	12	4.60	3.84	2.24	.76	2.36	.5, .3	.3, .7	170,120
102	Oct. 25	NE.	12	4.93	4.12	2.48	.81	2.45	.5, .3	.3, .7	188,790
103	Oct. 27	W.	9	4.66	3.89	1.85	.77	2.81	.5, .3	.3, .7	199,520
104	Oct. 28	NNW.	12	4.67	3.91	1.91	.76	2.76	.5, .3	.3, .7	200,900
105	Oct. 29	WNW.	10	4.58	3.98	2.18	.60	2.40	.5, .3	.3, .7	192,880
106	Oct. 31	NNE.	6	4.71	3.99	2.47	.72	2.24	.5, .3	.3, .7	194,150
107	...do....	SSE.	7	4.77	4.11	2.37	.66	2.40	.5, .3	.3, .7	184,780
108	Nov. 1	S.	10	4.70	3.93	1.95	.77	2.75	.5, .3	.3, .7	192,830
109	Nov. 3	NW.	14	4.58	3.63	1.55	.95	3.03	.5, .3	.3, .7	208,100
110	...do....	NW. SE.	12 5	4.64	3.85	2.26	.79	2.38	.5, .3	.3, .7	199,530
111	Nov. 4	SSW.	10	4.61	3.91	2.04	.70	2.57	.5, .3	.3, .7	188,420
112	Nov. 14	SW.	10	4.50	3.88	2.18	.62	2.32	.5, .3	.3, .7	185,450
113	Nov. 15	W.	14	4.33	3.47	1.34	.86	2.99	.5, .3	.3, .7	201,230
114	...do....	W.	12	4.38	3.62	1.94	.76	2.44	.5, .3	.3, .7	187,060
115	Nov. 17	NE.	14	4.73	4.03	1.94	.70	2.79	.5, .3	.3, .7	192,080
116	Nov. 19	SW.	11	4.56	3.84	2.14	.72	2.42	.5, .3	.3, .7	187,960
117	Nov. 20	SW.	8	4.59	3.84	2.07	.75	2.52	.5, .3	.3, .7	189,760

REPORT OF W. EDWARD WILSON, JUNIOR ENGINEER.

OFFICE OF SURVEY OF NORTHERN AND NORTHWESTERN LAKES,
Detroit, Mich., June 30, 1903.

MAJOR: I have the honor to submit the following report upon the operations of the party in my charge during the season of 1902:

Complying with your instructions I left Detroit June 15 for Detour, Mich., and removed the U. S. Lake Survey Automatic Gauge No. 16 from Point De Tour to Detour sawmill dock at Detour.

Upon completion of this work I left for Sault Ste. Marie, Mich., and arrived June 26, to continue the discharge measurements of the St. Marys River from the International Bridge.

The preliminary work of establishing the water gauges, erecting stationary platforms for supporting the reels used in lowering the meters into the water, relocating the still-water rating base at Point aux Pins, Canada, constructing a small dock for lowering the meters into the water for rating and overhauling the outfit to be used during the season was speedily completed.

Active field operations were commenced July 17 and continued until November 13. During this period a total of 149 discharges were measured at the International Bridge, the section was sounded in duplicate, several complete sets of velocity curves were observed, and 16 current meter ratings were determined on the still-water base at Wheeler Cove, Point aux Pins, Canada.

Office work was started upon the completion of the field work, and the writer reported at the Detroit office December 6. The work of reducing the data of the season's measurements was immediately begun, and was continued through the winter and spring until my departure for the field.

The location of the discharge section and the water gauges is given in my report of last year (see Report of Chief of Engineers, 1902, Part IV, p. 2872 et seq.) and is shown on plate No. 1 in this report. A brief description of the discharge section is as follows: The cross section (plate No. 2) is marked by the western or upstream side of the bridge, from which all of the observations were made. The bridge has 10 spans, each with a clear-water, width as given in the following Table No. 1:

TABLE 1.

Spans.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Clear water width	232.3	229.6	229.7	229.6	229.6	230.3	229.4	225.2	225.3	194.7

The first two spans on the American side are cut off from the rapids proper by a dam which forms the forebay of the Edison Sault Electric Company's power plant, only that volume of water being discharged that is used by the plant and the leakage through the dam. The remaining spans are in the rapids proper, and are of full-water width, with the exception of the tenth, where the shore line falls inside of the north abutment about 30 feet. The location of the water gauges that were used during the season are as follows:

U. S. Lake Survey Automatic Gauge ...... Southwest pier, American Ship Canal.
Gauge No. 1 on pier 2 .... International Bridge section, Edison Sault Electric Company's forebay.
Gauge No. 2 on pier 2 .... International Bridge section in rapids.
Gauge No. 3 on pier 9 .... International Bridge section in rapids.
Gauge No. 4, southwest pier .... Canadian Ship Canal.

These gauges were read simultaneously at ten-minute intervals from 7.30 a. m. to 4.30 p. m. daily (Sunday excepted) during the season.

The soundings of the section were taken about 10 feet apart, with a 150-pound lead weight attached to a ½-inch steel cable. The sounding weight was lowered by a reel from the bridge and the measurements referred to a datum on the guard rail. The very high velocity of the water, reaching 12 to 14 feet per second in some instances, made it very difficult to obtain correct depths, as the pressure of the current against the cable and weight made a large angle of inclination of the cable from the vertical. Corrections were applied wherever the angle exceeded 1 degree. Duplicate measurements of the section were made which assured a check upon the accuracy of the work.

The water surface of the section was measured with a special reel constructed for the work. The reel consisted of a base with two uprights containing bearings for a drum whose circumference was exactly 2 feet to the center of a ⅛-inch cable. The drum was wound with the cable, and the free end passed over a sheave exactly 0.5 foot in circumference at the center of the cable. The sheave rotated on a threaded shaft of 32 threads per inch. Attached to the free end of the cable was a 5-pound plumb bob. The water surface was measured to hundredths of a foot and referred to a datum on the guard rail of the bridge.

The velocity curves were measured with current meters suspended from a cable attached to reels on the bridge. The current meters gave the velocities of the water, which determined the relation between a fixed point called the index of a discharge station and all of the other points in the discharge station area. Each discharge station governed a definite part of the area of each span.

The following Table No. 2 shows the number of vertical velocity curve stations observed in each span:

TABLE 2.

Spans.	3.	4.	5.	6.	7.	8.	9.
Number of stations	14	13	13	15	14	14	10

A discharge measurement consisted in determining the velocity of the water with a Haskell current meter at the index point (in 1902, 0.4 depth) at each of the 19 discharge stations. The average time of measuring a discharge was about seventy to eighty minutes. The following Table No. 3 locates the discharge stations used in 1902:

TABLE NO. 3.—*Distance from water's edge of pier from American side.*

Stations.	Span 3.	Span 4.	Span 5.	Span 6.	Span 7.	Span 8.	Span 9.
1	46	46	48	46	46	41	46
2	109	109	109	109	109	104	109
3	184	184	183	184	184	178	184

The meters used during during the season were "U. S. Lake Survey Nos. 3B and 9B" of the Haskell propeller type. They were rated over a still-water base, 200 feet long, in Wheeler Cove, Point aux Pins, Canada. Two meters in rating were suspended 2 feet under the surface of the water on ¼-inch cables, fastened to the ends of a cross boom about 8 feet long, placed perpendicular to the rating base at the bow of the boat. The boat, guided by a base wire, was pulled by two to six men in alternate directions over this course at varying velocities corresponding to the range in the river velocities, by a continuous rope fastened to the bow and stretched in the form of a quadrilateral, one side of which was the towpath and another the rating base.

The efflux conditions in the rapids remained very constant during the season, as little work was done on the compensating works, located about 300 feet above the International Bridge, and extending into the rapids from the Canadian shore to a point perpendicular to the bridge at pier 8. The difficulty encountered in 1901 from log jams was obviated by having them removed as soon as they formed on the piers of the bridge.

The meter-rating observations were reduced by a least square determination of the curve using the straight line formula, $v = ar + b$, where v equals the velocity in feet per second, r equals the revolutions of meter per second, a equals the increment per revolution of meter, and b equals the intercept on the velocity axis, or, theoretically, the velocity with which the meter could be moved through the water without causing the meter head to revolve. Instead of using the quadratic equation $v = ar^2 + br + c$ for low velocities, the writer has used a straight line, thus obtaining two straight-line equations for the meter rating, one for high velocity, the other for low. This method of reduction answers very nicely, as the velocity in the river does not measure less than 2 or 3 feet per second, except in one or two instances. Table No. 4 gives a summary of the 1902 ratings, and shows a very interesting and instructive comparison of the absolute and relative ratings of each meter for the season.

TABLE 4.—*Summary of ratings, Meters L. S. 3 B and L. S. 9 B.*

Reference number of rating.	Date of rating.	Meter equipment.			Number of single observations.	Base.		Rating equation.	Intersection value of rating equations.		Absolute rating.					Relative rating.					Remarks.
		Meter number.	Standard.	Lead weight.		Length.	Location.				r = Revolutions per second.					r = Revolutions per second.					
											2.	3.	4.	5.	6.	2.	3.	4.	5.	6.	
									r.	v.	v = Velocity in feet per second.					Percentage velocity.					
	1902.			*Lbs*		*Ft.*															
1	July 29	3 B	Long	155	60	180	Wheeler Cove	$v=2.030r-0.154$ $v=1.828r+0.249$	1.956	3.817	3.906	5.936	7.966	9.996	12.026	49.0	74.5	100	125.4	150.9	3 B and 9 B meters rated simultaneously. Meters suspended from ends of boom 8 feet long, placed perpendicular to meter base at bow of boat. Depth of immersion to center of meter, 2 feet.
2	Sept. 3	3 B	...do...	155	58	200	...do...	$v=2.147r-0.251$ $v=1.819r+0.422$	2.052	4.154	4.043	6.190	8.337	10.484	12.631	48.5	74.2	100	125.7	151.5	
3	Sept. 5	3 B	Short	155	52	200	...do...	$v=2.149r-0.152$ $v=1.941r+0.279$	2.072	4.301	4.146	6.295	8.444	10.593	12.742	49.1	74.5	100	125.5	150.9	
4	Oct. 1	3 B	...do...	155	64	200	...do...	$v=2.153r-0.284$ $v=1.778r+0.481$	2.040	4.108	4.022	6.175	8.328	10.481	12.634	48.3	74.1	100	125.8	151.7	
5	Oct. 2	3 B	Long	155	56	200	...do...	$v=2.027r-0.060$ $v=1.812r+0.368$	1.991	3.976	3.994	6.021	8.048	10.075	12.102	49.6	74.8	100	125.2	150.4	
6	Nov. 1	3 B	Short	155	52	200	...do...	$v=2.126r-0.284$ $v=1.832r+0.350$	2.156	4.299	3.968	6.094	8.220	10.346	12.472	48.3	74.1	100	125.8	151.7	
7	Nov. 5	3 B	...do...	155	32	200	...do...	$v=2.136r-0.349$ $v=1.814r+0.361$	2.205	4.360	3.923	6.059	8.195	10.331	12.467	47.9	73.9	100	126.1	152.1	
8	July 29	9 B	Long	155	60	180	...do...	$v=2.223r-0.262$ $v=2.037r+0.122$	2.064	4.327	4.184	6.407	8.630	10.853	13.076	48.5	74.2	100	125.8	151.5	
9	Sept. 3	9 B	...do...	155	54	200	...do...	$v=2.135r-0.157$ $v=1.914r+0.283$	1.991	4.093	4.113	6.248	8.383	10.518	12.653	49.1	74.5	100	125.4	150.9	
10	Sept. 5	9 B	...do...	155	52	200	...do...	$v=2.124r-0.162$ $v=1.935r+0.222$	2.032	4.153	4.086	6.210	8.334	10.458	12.582	49.0	74.5	100	125.5	150.9	
11	....	9 B	...do...	155	....	....	International Bridge.	$v=2.37r-0.59$	......	......	4.15	6.52	8.89	11.26	13.63	46.7	73.3	100	126.7	153.3	Current rating with 3 B meter.
12	Oct. 1	9 B	...do...	155	64	200	Wheeler Cove	$v=2.176r-0.348$ $v=1.848r+0.340$	2.098	4.217	4.004	6.180	8.356	10.532	12.708	47.9	73.9	100	126.0	152.1	
13	Oct. 2	9 B	Short	155	56	200	...do...	$v=2.218r-0.321$ $v=2.000r+0.154$	2.179	4.512	4.115	6.333	8.551	10.769	12.987	48.1	74.1	100	125.9	151.9	
14	....	9 B	Long	155	....	....	International Bridge.	$v=2.34r-0.48$	......	......	4.20	6.54	8.88	11.22	13.56	47.3	73.6	100	126.4	152.7	Current rating with 3 B meter.
15	Nov. 1	9 B	...do...	155	52	200	Wheeler Cove	$v=2.244r-0.539$ $v=1.902r+0.298$	2.447	4.952	3.949	6.193	8.437	10.681	12.925	46.9	73.4	100	126.6	153.2	
16	Nov. 5	9 B	...do...	155	32	200	...do...	$v=2.276r-0.455$ $v=1.912r+0.261$	1.967	4.021	4.097	6.373	8.649	10.925	13.201	47.4	73.7	100	126.3	152.6	

The water surface observations have been reduced by determining the corresponding elevations of the water surface at each discharge station for the elevation of the water surface at gauge 2, pier 2. The former were plotted as abscissa and the latter as ordinates. The most probable line was drawn through the observations. The extreme stage observations of the station water surface plotted too large and were accounted for by not applying a correction due to the inclination of the cable caused by the pressure of the wind against it. These extreme stages of high and low water were always accompanied by winds of high velocity. The extreme observations are of little moment in the present case, as a straight line was found to be sufficiently accurate for the variations in stage as shown by section gauge 2, pier 2. The water surface measurements for the 19 discharge stations is given in Table No. 5. Only one span has been presented in graphical form in this report, but the characteristics shown in this one are the same for the remainder. Plates Nos. 3, 4, and 5 give the results of the three discharge stations in span 6.

TABLE 5.—*Water surface elevations, International Bridge section.*

Date.		Station 3-1.		Station 3-2.		Station 3-3.		Station 4-1.		Station 4-2.		Station 4-3.		Station 5-1.		Station 5-2.		Station 5-3.		Station 6-1.	
		Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.
1902.																					
Aug.	7	600.90	601.11	600.90	601.44	600.92	601.45	600.92	600.82	600.93	601.73	600.94	601.14	600.94	600.98	600.95	601.25	600.95	601.34	600.95	600.23
	7	.95	.09	.95	.41	.95	.41	.96	.58	.96	600.99	.96	.01	.97	601.00	.97	.36	.97	.41	.97	.20
	7	.99	.21	.99	.36	601.00	.68	601.00	.60	601.00	601.47	601.00	.30	601.01	.12	601.01	.46	601.01	.48	601.01	.40
	7	.91	.08	.90	.30	600.90	.38	600.90	.57	600.90	.29	600.90	.10	600.90	.05	600.90	.12	600.91	.24	600.91	.10
	8	601.12	.13	601.12	.70	601.12	.73	601.12	.61	601.12	.39	601.12	.38	601.13	.30	601.13	.68	601.14	.61	601.14	.49
	8	.12	.37	.12	.64	.12	.74	.12	.75	.13	.57	.14	.41	.14	.37	.14	.72	.15	.80	.15	.37
	8	.06	.31	.06	.53	.06	.68	.06	.85	.06	.39	.05	.28	.05	.18	.06	.43	.06	.53	.07	.42
	8	.02	.28	.02	.52	.03	.48	.01	.60	.02	.17	.02	.28	.04	.07	.04	.41	.03	.56	.04	.37
	9	600.88	.24	600.87	.29	600.87	.38	600.87	.43	600.88	.22	600.88	.06	600.86	.00	600.87	.09	600.87	.26	600.88	.10
	9	.97	.16			.97	.38	.97	.36	.95	.25	.95	.00	.94	.05	.93	.18	.93	.31	.94	.27
	11	601.10	.26	601.11	.68	601.11	.83	601.11	.87	601.10	.42	601.09	.33	601.08	.05	601.06	.60	601.07	.58	601.08	.42
	11	.18	.38	.19	.66	.19	.90	.20	.81	.20	.45	.20	.67	.20	.43	.20	.90	.20	.76	.20	.42
	11	.02	.11	.05	.29	.05	.56	.03	.77	.03	.22	.04	.23	.03	600.85	.04	.41	.05	.31	.05	.43
	11	.16	.01	.16	.45	.16	.76	.15	.90	.15	.49	.16	.30	.17	601.32	.17	.64	.17	.81	.17	.47
	12	600.95	.11	600.95	.39	600.93	.33	600.94	.50	600.94	.32	600.94	.23	600.93	.08	600.93	.27	600.93	.31	600.94	.17
	12	.92	.01	.92	.29	.92	.35	.92	.47	.93	.22	.93	.03	.93	600.98	.93	.14	.93	.31	.92	.17
	12	.81	600.93	.81	.09	.82	.23	.87	.40	.82	.12	.82	600.83	.82	.81	.82	600.94	.83	.14	.83	.02
	12	.99	601.11	.99	.45	.99	.44	.99	.50	.99	.39	.98	601.13	.97	601.08	.97	601.21	.96	.31	.96	.27
	13	.93	.11	.93	.36	.93	.44	.93	.41	.95	.42	.95	.16	.96	.12	.96	.37	.96	.41	.97	.27
	23	.99	.16	.99	.52	.98	.58	.98	.63	.98	.35	.99	.13	.99	.10	.99	.44	.98	.44	.98	.32
	23	601.02	.26	601.02	.64	601.02	.63	601.01	.85	601.01	.32	601.01	.23	601.01	.23	601.01	.51	601.00	.54	.99	.32
	25	600.99	.26	600.99	.49	600.99	.58	600.99	.65	600.96	.35	600.95	.23	600.95	.13	600.95	.29	600.95	.41	.95	.27
	25	601.04	.21	601.04	.54	601.05	.71	601.05	.60	601.05	.32	601.05	.28	601.05	.20	601.03	.46	601.02	.49	601.01	.32
	27	600.85	.01	600.85	.19	600.86	.23	600.86	.25	600.86	.37	600.87	600.98	600.87	600.93	600.88	.06	600.89	.26	600.90	.12
	27	.91	.16	.91	.34	.92	.43	.92	.45	.92	.42	.92	601.08	.92	601.00	.92	.16	.93	.34	.93	.15
Sept.	2	601.01	.36	601.02	.52	601.02	.61	601.01	.85	601.01	.67	601.00	.28	601.00	.20	601.00	.54	601.01	.54	601.02	.32
	2	600.90	.19	600.91	.37	600.91	.38	600.91	.63	600.91	.52	600.91	.11	600.91	.13	600.92	.34	600.92	.36	600.92	.20
	2	.93	.09	.93	.34	.93	.51	.92	.65	.92	.40	.92	.21	.91	.00	.91	.24	.91	.31	.91	.15
	4	601.09	.29	601.09	.77	601.09	.78	601.09	.80	601.09	.47	601.09	.48	601.09	.35	601.09	.66	601.09	.71	601.09	.50
	4	.13	.61	.13	.77	.14	.83	.16	.90	.16	.60	.14	.56	.13	.43	.14	.79	.15	.74	.15	.50
	4	.18	.44	.13	.82	.13	.78														
	4	.17	.61	.17	.89	.17	.91	.18	.90	.19	.92	.19	.81	.19	.55	.19	.86	.20	.86	.20	.65
	6	600.94	.24	600.94	.34	600.87	.46	600.84	.55	600.84	.47	600.88	.21	600.88	.03	600.88	.09	600.88	.26	600.88	.20
	6	601.01	.36	601.01	.64	601.02	.68	601.02	601.25	601.01	.42	601.01	.33	601.02	.30	601.03	.46	601.03	.56	601.04	.32
	9	.13	.46	.13	.79	.14	.93	.14	601.00	.14	.72	.13	.58	.13	.45	.13	.81	.13	.89	.13	.67
	9	.12	.46	.12	.72	.13	.81	.13	.00	.13	.67	.12	.68	.12	.60	.12	.76	.13	.81	.13	.67

Sept. 10	601.06	601.36	601.06	601.69	601.05	601.81	601.03	600.75	601.03	601.42	601.03	601.48	601.03	601.35	601.03	601.41	601.00	601.56	600.99	600.32
13	.15	.36	.15	.74	.16	.81	.16	.80	.16	.72	.15	.66	.14	.50	.14	.71	.14	.86	601.14	.57
15	600.92	.06	600.92	.34	600.94	.43	600.94	.35	600.94	.17	600.94	.16	600.94	.00	600.94	.16	600.94	.31	600.94	.20
15	.97	.31	.97	.49	.97	.48	.96	.50	.96	.22	.96	.33	.96	.10	.96	.26	.96	.36	.95	.15
16	.84	.16	.84	.24	.83	.28	.82	.05	.82	.17	.79	600.83	.79	600.80	.79	600.86	.78	600.96	.78	599.87
16	.96	.09	.96	.39	.96	.43	.96	.55	.96	.27	.95	601.23	.94	601.05	.94	601.11	.92	601.26	.92	600.12
16	.80	.01	.81	.14	.81	.23	.87	.40	.89	.27	.88	600.83	.86	600.90	.86	.01	.86	.01	.86	.02
16	.92	.16	.88	.34	.88	.41	.88	.55	.90	.42	.90	601.13	.90	601.00	.89	.11	.89	.24	.87	.12
17	.73	600.96	.77	.14	.79	.23	.79	.50	.81	.17	.80	600.83	.80	600.80	.79	600.96	.79	.01	.79	.02
17	.93	601.11	.92	.39	.92	.48	.92	.50	.93	.42	.93	601.18	.93	601.05	.92	601.11	.92	.21	.91	.12
17	.93	.06	.86	.34	.86	.33	.86	.45	.84	.27	.84	.03	.82	600.95	.83	.01	.82	.11	.79	.07
17	601.00	.21	601.00	.44	601.00	.53	601.00	.55	601.00	.27	.98	.28	.98	601.10	.97	.26	.96	.36	.94	.22
19	600.95	.06	600.94	.34	600.94	.48	600.94	.55	600.94	.27	.94	.21	.95	.00	.96	.19	.96	.31	.97	.17
19	.96	.06	.96	.34	.96	.53	.96	.45	.96	.42	.96	.18	.96	.05	.95	.16	.94	.31	.94	.12
20	.91	.06	.91	.34	.91	.43	.91	.70	.90	.37	.89	.13	.87	600.95	.87	.06	.87	.16	.87	.07
20	601.00	.36	601.02	.49	601.02	.53	601.02	.55	601.00	.47	601.00	.28	601.00	601.18	.99	.36	.99	.41	601.00	.22
20	600.85	.11	600.85	.14	600.85	.28	600.85	.55	600.85	.37	600.86	.03	600.87	600.90	.88	.06	.89	.19	600.91	.07
20	.93	.16	.93	.39	.92	.48	.91	.60	.91	.37	.91	.08	.91	601.05	.91	.16	.91	.31	.91	.17
22	601.01	.31	601.01	.47	601.02	.63	601.02	.65	601.02	.47	601.02	.28	601.02	.30	601.02	.41	601.02	.56	601.02	.32
22	.00	.31	.00	.54	.00	.58	.01	.65	.01	.57	.01	.38	.01	.20	.01	.41	.00	.51	600.99	.25
22	600.98	.36	.00	.54	.00	.56	.02	.65	.01	.52	.02	.28	.02	.30	.02	.44	.02	.56	601.02	.32
22	601.00	.26	600.99	.44	600.99	.42	600.99	.65	600.97	.32	600.97	.28	600.97	.10	600.95	.36	600.95	.41	600.95	.22
23	.04	.36	601.05	.54	601.05	.68	601.05	.65	601.06	.37	601.06	.23	601.07	.35	601.07	.46	601.06	.56	601.06	.32
23	.01	.26	.01	.49	.01	.58	600.99	.65	600.99	.52	600.97	.18	600.96	.05	600.95	.31	600.96	.41	600.97	.22
23	.02	.26	.02	.37	.02	.61	601.02	.65	601.02	.47	601.01	.38	601.01	.15	601.01	.36	601.00	.41	601.00	.27
23	.10	600.86	.10	.64	.10	.78	.10	.65	.10	.42	.10	.38	.09	.40	.09	.56	.08	.61	.08	.42
24	600.90	601.11	600.88	.34	600.88	.41	600.87	.45	600.85	.37	600.84	600.98	600.86	600.90	600.86	.01	600.86	.16	600.85	.02
24	.90	.21	.90	.34	.90	.41	.88	.65	.88	.47	.88	601.08	.87	.95	.87	.06	.87	.21	.87	.12
24	.96	.06	.96	.39	.96	.51	.95	.65	.95	.47	.93	.18	.93	601.05	.93	.21	.94	.36	.94	.17
24	.94	600.96	.94	.34	.93	.48	.93	.65	.93	.47	.93	.31	.93	.05	.94	.21	.95	.36	.95	.12
25	.90	601.16	.90	.34	.90	.48	.89	.65	.88	.47	.88	.08	.87	.00	.86	.06	.86	.16	.86	.07
25	.78	600.86	.78	.09	.78	.28	.80	.65	.80	.47	.79	600.88	.79	600.80	.79	600.96	.81	.06	.81	.02
25	.90	601.16	.91	.29	.92	.48	.92	.65	.92	.42	.92	601.18	.92	601.00	.93	601.16	.93	.36	.87	.12
25	.81	.08	.81	.24	.82	.33	.82	.65	.82	.22	.81	.05	.81	600.87	.81	600.96	.81	.09	.81	.05
26	.95	.26	.96	.44	.96	.63	.96	.83	.95	.47	.95	.36	.96	601.15	.96	601.31	.95	.51	.94	.32
26	.85	.18	.85	.29	.85	.36	.85	.70	.84	.47	.84	.18	.84	600.92	.84	.06	.84	.26	.83	.10
26	.91	.21	.91	.44	.90	.63	.90	.60	.90	.47	.90	.18	.90	601.10	.90	.24	.90	.36	.87	.25
26	.90	.26	.91	.39	.91	.53	.91	.63	.90	.37	.90	.23	.89	.10	.88	.16	.88	.31	.88	.14
27	601.02	.26	601.02	.56	601.02	.57	601.01	.63	601.01	.32	601.00	.24	.95	.10	.95	.26	.92	.36	.92	.20
27	600.88	.16	600.88	.25	600.86	.33	600.84	.70	600.84	.17	600.82	600.98	.81	600.83	.81	600.91	.81	.08	.81	.01
27	.96	.16	.94	.39	.93	.43	.91	.50	.89	.45	.86	601.13	.85	.95	.84	601.01	.82	.16	.81	599.97
27	601.00	.18	601.00	.46	601.00	.53	601.02	.67	601.02	.47	601.02	.28	601.02	601.23	601.02	.46	601.01	.54	601.00	600.29
29	600.95	.24	600.95	.44	600.96	.53	600.96	.57	600.96	.42	600.96	.35	600.96	.15	600.96	.34	600.96	.43	600.95	.27
29	.96	.25	.96	.44	.96	.56	.96	.93	.96	.27	.96	.33	.96	.15	.96	.28	.96	.43	.96	.27
29	.93	.24	.93	.39	.93	.55	.94	.85	.95	.54	.95	.25	.94	.05	.93	.18	.93	.31	.93	.15
29	.93	.16	.93	.41	.92	.53	.92	.63	.92	.52	.91	.28	.91	.08	.90	.13	.89	.31	.89	.17
30	601.08	.41	601.08	.66	601.08	.76	601.07	.77	601.06	.47	601.06	.33	601.07	.38	601.08	.58	601.09	.69	601.09	.42
30	.22	.56	.22	.84	.22	602.08	.22	.95	.22	.92	.21	.88	.21	.67	.20	.91	.20	.94	.20	.68
30	600.93	.09	600.93	.34	600.93	601.48	600.92	.95	600.92	.57	600.92	.30	600.93	.58	600.93	.19	600.94	.41	600.95	.27
30	601.15	.48	601.15	.82	601.16	.88	601.16	.93	601.16	.52	601.15	.58	601.15	.46	601.15	.78	601.15	.77	601.15	.62
Oct. 3	.00	.36	.00	.54	.00	.66	.00	.65	600.99	.37	600.99	.28	600.99	.23	600.99	.34	600.99	.51	600.99	.32
3	.00	.26	.02	.57	.02	.68	.02	.75	601.03	.49	601.03	.38	601.02	600.80	601.02	.54	601.02	.58	601.01	.32

TABLE 5.—*Water surface elevations, International Bridge section*—Continued.

Date.	Station 3-1.		Station 3-2.		Station 3-3.		Station 4-1.		Station 4-2.		Station 4-3.		Station 5-1.		Station 5-2.		Station 5-3.		Station 6-1.	
	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water service.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water service.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water service.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water service.
1902.																				
Oct. 4	600.97	601.24	600.98	601.42	600.98	601.56	600.99	600.70	600.99	601.45	600.99	601.28	600.99	600.75	600.98	601.32	600.99	601.46	600.99	600.29
4	.95	.16	.95	.39	.95	.55	.94	.60	.93	.37	.93	.16	.92	601.02	.92	.16	.92	.36	.92	.19
6	.95	.19	.95	.37	.95	.50	.94	.80	.94	.77	.94	.23	.93	.10	.93	.28	.94	.41	.95	.25
6	.98	.18	.99	.49	601.00	.58	601.00	.58	601.00	.49	601.00	.38	601.00	.18	601.01	.33	601.01	.51	601.01	.27
16	.88	.11	.90	.34	600.91	.49	600.91	.70	600.93	.42	600.93	.28	600.93	.05	600.93	.28	600.94	.36	600.94	.27
17	.74	.01	.76	.18	.75	.18	.73	.60	.73	.16	.73	.06	.73	600.82	.73	600.88	.73	600.91	.74	599.82
20	.95	.42	.95	.34	.94	.53	.94	.60	.94	.54	.94	.34	.94	601.10	.94	601.26	.94	601.41	.94	600.42
20	601.12	.37	601.12	.69	601.12	.88	601.12	.85	601.12	.52	601.12	.54	601.11	.45	601.10	.62	601.10	.67	601.09	.52
20	.01	.41	.01	.49	.01	.53	.01	.60	.00	.47	.00	.33	.00	.25	600.99	.36	600.98	.46	600.98	.42
20	600.98	.05	600.98	.50	600.98	.43	600.98	.60	600.99	.25	.00	.28	.00	.25	601.01	.36	601.01	.37	601.01	.32
21	.80	.06	.80	.14	.79	.28	.79	.41	.74	.07	600.71	600.94	600.71	600.72	600.71	600.91	600.70	600.86	600.70	599.87
21	.90	.36	.89	.54	.88	.33	.87	.35	.87	.10	.87	601.08	.87	.96	.87	601.11	.86	601.24	.86	600.05
21	.81	.16	.80	.36	.80	.49	.80	.45	.85	.57	.85	.20	.80	601.07	.77	.15	.76	.30	.77	.17
21	.72	.26	.74	.34	.75	.41	.75	.40	.74	.49	.74	.13	.74	600.98	.73	.16	.73	.21	.73	.12
22	.83	.26	.83	.39	.83	.37	.83	.57	.82	.52	.82	.23	.82	601.10	.81	.28	.81	.36	.81	.32
22	.79	.26	.80	.39	.80	.48	.81	.52	.81	.44	.81	.12	.81	.05	.81	.26	.82	.33	.82	.32
22	.95	.43	.95	.66	.96	.70	.96	.67	.96	.52	.96	.54	.96	.35	.97	.48	.98	.65	.97	.47
22	.84	.34	.83	.46	.82	.48	.79	.58	.79	.42	.80	.56	.81	.13	.81	.24	.82	.36	.83	.32
23	.73	600.99	.73	.07	.73	.11	.72	.45	.72	.06	.71	.00	.71	600.74	.70	600.83	.68	600.86	.68	599.82
23	.56	.71	.56	.09	.54	600.88	.53	.40	.53	600.59	.51	600.50	.51	.45	.52	.64	.53	.68	.53	.77
23	.66	.91	.66	600.95	.67	601.08	.67	.41	.74	601.07	.72	601.00	.72	.65	.69	.90	.67	.79	.64	.82
23	.53	.76	.53	.84	.51	600.88	.48	.26	.48	600.27	.46	600.58	.43	.30	.42	.46	.42	.46	.41	.57
24	601.04	601.39	601.05	601.64	601.05	601.82	601.07	.70	601.07	601.49	601.08	601.33	601.10	601.45	601.10	601.68	601.12	601.60	601.12	600.50
24	.02	.26	.04	.56	.04	.73	.03	.70	.03	.47	.03	.33	.03	.40	.03	.51	.03	.51	.03	.37
24	.24	.64	.23	602.07	.22	602.08	.22	.97	.21	602.07	.21	.95	.21	.55	.21	.86	.21	602.07	.21	.82
24	.20	.41	.20	601.87	.20	.03	.24	601.15	.24	601.82	.25	.95	.26	.90	.26	602.16	.27	.24	.27	.97
25	600.85	.21	600.85	.32	600.83	601.28	600.82	600.35	600.82	.38	600.84	.08	600.85	600.95	600.85	601.06	600.84	601.24	600.83	.02
25	.75	600.99	.74	.07	.74	.13	.73	.25	.73	.17	.73	.03	.73	.80	.73	600.89	.73	.04	.74	599.92
25	.76	.81	.76	.14	.75	.28	.74	.65	.74	600.97	.73	600.98	.72	.86	.72	.88	.71	600.91	.71	.92
25	.80	601.06	.81	.18	.81	.28	.79	.35	.79	601.26	.79	.99	.77	.81	.77	.91	.77	601.09	.78	.82
27	601.03	.28	601.01	.63	601.00	.61	601.00	.77	.98	.33	.96	601.50	.94	601.26	.94	601.29	.93	.39	.93	600.28
27	600.95	.16	600.95	.39	600.94	.50	600.94	.61	600.94	.27	.95	.38	.95	.10	.94	.20	.94	.41	.94	.42
27	601.06	.46	601.06	.53	601.05	.67	601.04	.70	601.04	.37	601.04	.34	601.04	.30	601.04	.42	601.03	.54	601.02	.41
27	.01	.18	.01	.64	.01	.63	.00	.77	.00	.42	.00	.34	600.99	.35	600.99	.42	600.99	.51	600.99	.32
28	.03	.36	.03	.60	.02	.64	.01	.55	.00	.22	600.99	.33	.99	.15	.97	.36	.97	.46	.96	.28
28	600.95	.16	600.95	.54	600.94	.58	600.93	.55	600.93	.24	.93	.19	.93	.10	.93	.28	.93	.34	.93	.32

Date.																				
Oct. 28	601.08	601.38	601.08	601.64	601.08	601.73	601.08	600.79	601.07	601.47	601.07	601.44	601.07	601.42	601.07	601.58	601.07	601.67	601.07	600.54
28	.07	.38	.07	.70	.06	.70	.05	.62	.05	.19	.03	.26	.03	.30	.02	.86	.02	.61	.02	.42
Nov. 7	600.91	.18	600.91	.37	600.91	.41	600.89	.55	600.87	.45	600.87	.05	600.84	600.96	600.84	.11	600.85	.24	600.85	.14
8	.81	.24	.80	.34	.80	.36	.80	.62	.84	.50	.84	.17	.87	601.02	.87	.08	.87	.32	.87	.21
8	.81	.10	.80	.19	.80	.34	.78	.53	.77	.22	.75	.06	.74	600.82	.74	600.96	.76	.14	.76	.07
8	.94	.24	.94	.42	.96	.53	.96	.63	.98	.27	.99	.35	.99	601.25	.99	601.41	.99	.54	.98	.32
8	.73	.08	.73	.14	.72	.19	.72	.58	.72	.01	.72	.00	.72	600.80	.73	600.98	.73	600.96	.72	.04

Date.	Station 6-2. Elevation gauge 2.	Station 6-2. Corresponding elevation water surface.	Station 6-3. Elevation gauge 2.	Station 6-3. Corresponding elevation water surface.	Station 7-1. Elevation gauge 2.	Station 7-1. Corresponding elevation water surface.	Station 7-2. Elevation gauge 2.	Station 7-2. Corresponding elevation water surface.	Station 7-3. Elevation gauge 2.	Station 7-3. Corresponding elevation water surface.	Station 8-1. Elevation gauge 2.	Station 8-1. Corresponding elevation water surface.	Station 8-2. Elevation gauge 2.	Station 8-2. Corresponding elevation water surface.	Station 8-3. Elevation gauge 2.	Station 8-3. Corresponding elevation water surface.	Station 9-1. Elevation gauge 2.	Station 9-1. Corresponding elevation water surface.	Station 9-2. Elevation gauge 2.	Station 9-2. Corresponding elevation water surface.
1902. Aug. 7	600.95	600.81	600.95	601.24	600.97	600.01	600.97	600.81	600.98	600.74	600.98	--------	600.99	599.85	600.99	599.23	601.00	598.99	601.00	599.10
7	.98	.89	.99	.28	601.00	.04	601.01	.74	601.00	.82	.99	599.51	.99	.83	.99	.21	600.99	.99	--------	--------
7	601.00	.96	.99	.33	600.98	.06	600.97	.69	600.96	.67	.96	.33	.95	.61	.95	.28	.95	.99	600.94	.02
7	600.90	.67	.89	600.98	.89	.05	.89	.59	.90	.62	.92	.30	.92	.53	.92	.21	.93	.89	--------	--------
8	601.13	601.26	601.13	601.67	601.13	.24	601.14	.83	601.15	601.17	601.16	.45	601.17	.85	601.17	.55	601.17	599.14	601.16	.06
8	.15	.17	.14	.53	.14	.23	.13	.89	.14	.24	.14	.33	.15	.73	.15	.50	.15	.09	--------	--------
8	.07	.00	.07	.48	.07	.08	.06	601.04	.06	600.89	.06	.49	.06	.81	.06	.46	.07	598.99	.07	.10
8	.05	.01	.07	.45	.07	.23	.07	600.35	.07	.89	.07	.37	.07	.59	.07	.31	.07	599.09	--------	--------
9	600.90	600.69	600.90	.00	600.90	599.96	600.90	.48	600.89	.65	600.89	.13	600.88	.56	600.89	.11	600.90	598.87	600.90	598.87
9	.95	.74	.95	.13	.95	.96	.95	.73	.96	.77	.96	.28	.94	.59	.91	.21	.91	.87	--------	--------
11	601.09	601.09	601.10	.38	601.11	600.11	601.12	.81	601.13	601.20	601.14	.48	601.14	.96	601.15	.58	601.15	599.17	601.15	599.18
11	.20	.11	.20	.83	.19	.36	.18	.89	.18	.11	.16	.41	.16	.89	.16	.43	.15	.17	--------	--------
11	.06	600.87	.07	.26	.07	.04	.08	.42	.09	600.84	.11	.18	.13	600.26	.13	.39	.13	.04	.14	.15
11	.17	601.24	.17	.56	.17	.21	.17	.86	.17	601.00	.16	.35	.15	599.86	.15	.46	.15	.02	--------	--------
12	600.94	600.74	600.96	.06	600.97	.06	600.96	.56	600.96	600.70	600.96	.23	600.96	.96	600.96	.42	600.97	598.83	600.97	598.88
12	.93	.80	.94	.07	.94	.00	.95	.42	.95	.78	.96	.35	.97	.86	.97	.36	.96	.79	--------	--------
12	.85	.64	.86	600.93	.86	599.98	.87	.59	.87	.58	.88	.11	.88	.61	.88	.26	.89	.71	--------	--------
12	.95	.74	.94	601.07	.94	600.04	.95	.67	.95	.64	.94	.28	.94	.73	.93	.26	.92	.75	.90	.72
13	.97	.93	.98	.23	.98	.11	.98	.62	.97	.78	.96	.28	.96	.86	.95	.26	.94	.75	.92	599.05
23	.97	.87	.96	.08	.95	.06	.95	.79	.94	.75	.94	.23	.93	.66	.92	.41	.92	.74	.92	598.95
23	.98	601.07	.97	.38	.96	.16	.94	.81	.93	.82	.93	.23	.92	.81	.92	.26	.92	.74	--------	--------
25	.95	600.84	.95	.23	.94	.11	.94	.81	.93	.77	.93	.33	.92	--------	.91	.31	.91	.79	.90	.95
26	601.01	.94	601.01	.38	601.01	.06	.99	.86	.99	.87	.98	.36	.96	.64	.96	.16	.92	.79	.90	.90
27	600.90	.74	600.91	.13	600.91	.08	.91	.86	.94	.77	.97	.38	.97	.66	.95	.29	.97	599.02	.97	599.13
27	.95	.79	.95	.21	.95	.04	.96	.76	.96	.82	.96	.33	.97	.69	.97	.06	.96	598.79	.96	598.90
Sept. 2	601.03	601.02	601.04	.41	601.05	.16	601.06	.91	601.07	.85	601.07	.66	601.08	.66	601.08	.34	601.06	599.02	601.05	599.13
2	600.92	600.82	600.93	.18	600.94	.14	600.95	.69	600.95	.85	600.96	.46	600.98	.84	.01	.41	.02	598.99	.02	.10
2	.91	.77	.90	.08	.90	.01	.89	.64	.88	.67	.88	.33	.89	.41	600.89	598.98	600.87	.77	600.86	598.80
4	601.10	601.12	601.11	.56	601.12	.26	601.13	.81	601.13	601.12	601.12	.58	601.12	.86	601.12	599.31	601.12	599.07	601.14	.95
4	.15	.29	.15	.71	.15	.26	.14	.84	.14	.15	.14	.73	.14	.86	.14	.36	.14	.07	--------	--------

TABLE 5.—*Water surface elevations, International Bridge section*—Continued.

Date.	Station 6-2.		Station 6-3.		Station 7-1.		Station 7-2.		Station 7-3.		Station 8-1.		Station 8-2.		Station 8-3.		Station 9-1.		Station 9-2.	
	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.
1902. Sept. 4	------	------	------	------	------	------	------	------	601.18	------	601.19	599.63	601.18	599.76	601.19	599.51	601.19	599.07	601.19	599.20
4	601.20	601.34	601.21	601.93	601.21	600.36	601.21	600.96	.21	601.20	.21	.51	.21	.81	.21	.49	.20	.29	------	------
6	600.90	600.77	600.91	.16	600.91	.16	600.91	.64	600.91	600.72	600.93	.33	600.94	.44	600.96	.26	.00	598.99	.00	598.95
6	601.04	.99	601.03	.36	601.01	.16	601.01	.76	601.00	.82	601.00	.38	601.02	.76	601.02	.41	.02	.89	.03	599.10
9	.14	601.29	.15	.83	.15	.26	.17	601.04	.17	601.32	.16	.73	.15	.76	.15	.46	.14	599.19	.14	.25
9	.13	.29	.13	.78	.13	.36	.13	600.99	.13	.27	.15	.53	.16	.81	.17	.56	.18	.19	.18	.20
10	600.97	600.94	600.95	.28	600.95	.36	600.94	.74	600.94	600.90	600.92	.28	600.92	.66	600.91	.36	600.91	598.84	600.89	598.90
13	601.14	601.29	601.14	.73	601.14	.36	601.14	601.04	601.14	601.22	601.14	.46	601.13	.81	601.13	.31	601.13	599.09	601.11	599.05
15	600.93	600.74	600.92	.03	600.92	.06	600.93	600.61	600.93	600.65	600.94	.28	600.95	.46	600.96	.16	600.96	598.84	600.96	598.95
15	.94	601.14	.94	.11	.95	.94	.95	.64	.95	.72	.95	.33	.95	.49	.95	.16	.95	.89	------	------
16	.78	600.44	.78	600.78	.78	599.91	.78	.36	.78	.35	.78	.23	.79	.01	.79	598.96	.80	.64	.81	.80
16	.91	.59	.90	.98	.90	600.06	.89	.51	.88	.60	.87	.28	.86	.31	.86	.96	.82	.69	------	------
16	.84	.54	.83	.88	.81	599.91	.80	.46	.79	.45	.79	.13	.79	.11	.79	599.04	.79	.79	.79	.75
16	.85	.62	.83	.91	.81	.86	.78	.46	.78	.42	.77	.13	.77	.11	.77	598.96	.77	.79	------	------
17	.80	.59	.81	.88	.82	.91	.83	.46	.83	.52	.82	.18	.81	.01	.80	599.01	.79	.74	.79	.75
17	.90	.69	.90	601.08	.91	600.01	.88	.56	.88	.62	.87	.28	.83	.06	.81	.01	.81	.74	------	------
17	.79	.59	.75	600.73	.74	599.86	.73	.56	.73	.42	.73	.28	.73	.06	.74	598.96	.75	.84	.76	.80
17	.92	.79	.89	.98	.86	600.01	.83	.61	.80	.57	.79	.23	.79	.21	.79	599.01	.78	.79	------	------
19	.97	.84	.97	601.11	.97	.04	.97	.61	.97	.72	.96	.23	.96	.46	.97	.11	.98	.84	.98	.90
19	.95	.74	.95	.08	.96	599.96	.96	.51	.98	.67	.99	.28	.99	.66	.98	.21	.98	.89	------	------
20	.88	.69	.89	600.98	.91	600.01	.91	.66	.92	.67	.92	.33	.93	.21	.93	.06	.93	.84	.93	.95
20	601.00	.89	601.00	601.23	601.00	.06	601.00	.71	601.00	.82	.99	.38	.98	.66	.96	.41	.94	.84	------	------
20	600.91	.69	600.91	.03	600.91	.01	600.91	.66	600.91	.57	.91	.23	.90	.21	.89	.21	.89	.79	.89	.85
20	.91	.74	.92	.08	.92	.01	.92	.61	.93	.67	.93	.28	.92	.08	.93	.16	.90	.89	------	------
22	601.02	.99	601.02	.33	601.01	.09	601.00	.81	601.00	.87	.99	.53	.98	.71	.98	.21	.96	.89	.96	599.05
22	600.98	.92	600.97	.23	600.96	.06	600.96	.66	600.95	.80	.95	.46	.95	.71	.95	.46	.95	.94	------	------
22	601.02	.82	601.02	.36	601.02	.16	601.02	.91	601.03	.92	601.03	.48	601.00	.61	601.00	.26	.99	.99	.98	.05
22	600.95	.84	600.95	.08	600.94	.26	600.94	.66	600.94	.72	600.93	.46	600.93	.61	600.95	.26	.96	.99	------	------
23	601.06	.99	601.05	.31	601.05	.16	601.05	.81	601.04	.92	601.03	.33	601.03	.66	601.02	.31	601.02	.99	601.01	.05
23	600.97	.84	600.97	.18	600.97	.11	600.97	.76	600.96	.75	600.96	.38	600.96	.26	600.95	.16	600.95	.89	------	------
23	601.00	.84	601.00	.28	601.00	.11	601.02	.81	601.03	.77	601.04	.38	601.04	.81	601.04	.31	601.04	.94	.05	.05
23	.08	601.09	.07	.38	.07	.06	.07	.91	.07	.95	.06	.48	.05	.76	.05	.16	.05	.94	------	------
24	600.84	600.62	600.83	600.93	600.83	599.96	600.82	.61	600.82	.52	600.81	.13	600.81	.16	600.81	.06	600.82	.69	600.82	598.75
24	.87	.54	.86	.98	.86	600.06	.85	.56	.84	.52	.84	.23	.84	.31	.84	.06	.84	.79	------	------
24	.94	.79	.94	601.13	.94	.01	.95	.76	.95	.72	.95	.28	.95	.51	.95	.11	.95	.79	.95	599.00
24	.95	.79	.95	.08	.95	.01	.94	.61	.94	.62	.94	.23	.95	.41	.95	.16	.95	.79	------	------

Sept. 25	600.86	600.64	600.85	600.88	600.84	600.01	600.83	600.56	600.83	600.57	600.84	599.28	600.84	599.16	600.84	599.06	600.84	598.84	600.82	598.80
25	.81	.59	.82	.88	.82	.01	.82	.51	.82	.52	.82	.23	.82	.16	.83	.11	.83	.74	--------	--------
25	.87	.72	.87	.98	.87	.11	.86	.61	.86	.54	.85	.23	.84	.31	.83	.16	.83	.97	.83	.92
25	.82	.64	.83	.95	.84	.04	.84	.61	.84	.45	.84	.43	.84	.11	.83	.21	.83	.89	--------	--------
26	.93	.89	.93	601.28	.92	.16	.92	.69	.92	.82	.91	.38	.91	.41	.90	.23	.89	.97	.88	599.02
26	.83	.69	.83	600.88	.83	.13	.83	.46	.82	.62	.82	.41	.82	.21	.81	.19	.81	.82	.81	598.85
26	.86	.81	.85	601.00	.85	.08	.85	.76	.85	.72	.85	.33	.85	.39	.85	.19	.84	.92	.84	.95
26	.88	.69	.88	.06	.86	.11	.86	.61	.86	.55	.85	.33	.85	.33	.85	.17	.85	.87	--------	--------
27	.92	.77	.92	.15	.92	.06	.91	.63	.91	.70	.91	.43	.91	.36	.91	.11	.90	.79	.89	.97
27	.82	.59	.82	600.86	.82	599.96	.82	.43	.82	.47	.82	.18	.82	.19	.82	.11	.82	.72	--------	--------
27	.81	.56	.80	.83	.80	.94	.80	.51	.80	.45	.80	.18	.80	.11	.79	.11	.80	.76	.82	.83
27	.99	.94	.97	601.26	.95	600.09	.95	.64	.94	.72	.94	.43	.93	.52	.93	.18	.92	.87	--------	--------
29	.95	.91	.95	.21	.96	.13	.96	.76	.96	.82	.96	.41	.96	.56	.95	.29	.94	.91	.93	599.05
29	.97	.87	.97	.28	.96	.16	.96	.78	.96	.62	.96	.36	.96	.53	.96	.26	.95	.99	--------	--------
29	.93	.81	.93	.18	.93	.13	.91	.76	.90	.64	.90	.40	.91	.37	.91	.19	.90	.87	.89	598.95
29	.90	.77	.90	.01	.90	.14	.91	.71	.91	.72	.91	.49	.91	.44	91	.26	.88	.86	--------	--------
30	601.08	601.09	601.07	.50	601.07	.23	601.08	.76	601.08	601.07	601.08	.53	601.08	.81	601.09	.31	601.10	599.09	601.10	599.20
30	.19	.29	.18	.88	.16	.46	.14	601.11	.13	.07	.12	.68	.11	.76	.10	.31	.09	.29	--------	--------
30	600.95	600.80	600.96	.06	600.96	.16	600.96	600.73	600.97	600.72	600.98	.43	600.99	.59	.00	.40	.00	598.96	.02	.05
30	601.15	601.24	.14	.68	601.13	.26	601.13	.96	601.12	601.02	601.11	.51	601.10	.71	.09	.38	.07	599.04	--------	--------
Oct. 3	600.99	600.92	600.99	.28	600.99	.16	600.99	.72	600.99	600.94	600.99	.53	600 99	.66	.00	.21	.01	598.97	.01	.08
3	601.01	.99	601.02	.40	601.02	.21	601.01	.84	601.00	.90	.99	.50	.99	.76	600.98	.24	600.98	599.04	--------	--------
4	600.98	.92	600.97	.25	600.96	.06	600.96	.58	600.97	.77	.97	.53	.96	.64	.96	.21	.96	598.94	600.93	.02
4	.92	.77	.92	.06	.93	.03	.93	.56	.92	.70	.91	.41	.90	.31	.90	.19	.90	.84	.91	598.92
6	.95	.87	.95	.18	.95	.16	.95	.62	.95	.67	.94	.40	.95	.66	.95	.26	.94	.94	.93	.98
6	601.00	.97	601.00	.30	.99	.16	.99	.66	.99	.89	.98	.55	.98	.73	.99	.56	601.01	.97	601.02	599.10
16	600.94	.89	600.93	.28	.93	.21	.94	.83	.94	.79	.94	.48	.94	.49	.92	.21	600.91	.89	600.92	.05
17	.75	.49	.75	600.80	.76	599.91	.77	.61	.77	.50	.77	.28	.77	.21	.79	.16	.80	.79	.81	598.88
20	.93	.89	.93	601.18	.92	600.10	.92	.71	.92	.67	.92	.44	.92	.45	.92	.21	.91	.94	.91	.95
20	601.08	601.19	601.08	.58	601.07	.26	601.07	.93	601.06	.91	.95	.43	.95	.71	.93	.31	.92	.94	--------	--------
20	600.99	600.89	.00	.23	.01	.26	.01	.91	.01	601.00	601.01	.48	601.01	.58	601.01	.36	601.02	599.09	601.02	599.00
20	601.00	.99	.00	.23	.01	.18	.02	.96	.03	600.82	.02	.48	.02	.66	.02	.26	.02	.06	--------	--------
21	600.71	.44	600.71	600.73	600.72	599.91	600.74	.59	600.82	.47	600.82	.23	600.83	.11	600.83	.21	600.83	598.79	600.82	598.83
21	.86	.67	.86	601.01	.86	600.01	.85	.56	.85	.54	.84	.33	.84	.21	.84	.11	.83	.84	--------	--------
21	.77	.74	.77	.03	.78	599.91	.79	.81	.79	.72	.79	.53	.79	.50	.77	.31	.75	.99	.74	.98
21	.74	.64	.74	.08	.75	600.21	.76	.81	.76	.67	.77	.53	.77	.50	.76	.27	.74	.79	--------	--------
22	.80	.87	.80	.20	.80	.16	.80	.91	.81	.68	.81	.53	.82	.41	.83	.31	.83	.99	.83	599.02
22	.82	.81	.81	.13	.81	.21	.81	.81	.81	.84	.81	.53	.82	.45	.83	.31	.83	.99	--------	--------
22	.96	601.09	.95	.46	.96	.36	.98	.19	.98	.95	.98	.71	.98	.61	.96	.46	.95	599.17	.94	.25
22	.84	600.88	.85	.18	.85	.26	.86	.91	.87	.85	.87	.63	.88	.61	.89	.47	.90	.14	--------	--------
23	.68	.50	.68	600.70	.68	599.86	.68	.51	.67	.40	.65	.29	.64	.03	.62	.31	.61	598.54	.58	598.62
23	.54	.29	.55	.53	.56	.71	.56	.25	.56	.22	.57	.23	.57	.06	.56	.06	.55	.61	--------	--------
23	.62	.29	.60	.62	.57	.66	.54	.23	.53	.12	.51	.25	.48	598.86	.46	598.77	.43	.42	.42	.52
23	.41	.01	.42	.28	.42	.54	.41	599.91	.40	599.92	.40	.23	.41	.76	.42	.81	.42	.34	--------	--------
24	601.11	601.09	601.10	601.58	601.08	600.21	601.07	601.17	601.06	600.92	601.06	.38	601.03	599.66	601.01	599.21	.99	599.04	.97	599.10
24	.03	600.99	.04	.53	.04	.16	.03	.06	.02	.92	.00	.48	600.99	.57	600.97	.21	.97	598.89	--------	--------
24	.21	601.51	.23	602.27	.23	.62	.23	.27	.23	601.37	.23	.68	601.24	600.06	601.24	.66	601.24	599.21	601.25	.43
24	.27	.69	.27	601.98	.27	.73	.28	.53	.28	.32	.28	.88	.27	.31	.28	.46	.27	.34	--------	--------
25	600.83	600.73	600.82	600.98	600.82	599.99	600.82	600.73	600.82	600.62	600.82	.45	600.81	599.27	600.80	.19	600.80	598.84	600.79	598.89
25	.74	.49	.74	.83	.75	.90	.75	.36	.76	.52	.76	.28	.77	.16	.78	.21	.79	.79	--------	--------
25	.71	.53	.70	.80	.70	.86	.70	.51	.69	.46	.68	.33	.68	.06	.69	.01	.69	.61	.70	.80
25	.78	.51	.78	.78	.78	.96	.78	.16	.76	.47	.75	.23	.74	.21	.73	.01	.71	.69	--------	--------

TABLE 5.—*Water surface elevations. International Bridge section*—Continued.

Date.	Station 6-2.		Station 6-3.		Station 7-1.		Station 7-2.		Station 7-3		Station 8-1.		Station 8-2.		Station 8-3.		Station 9-1.		Station 9-2.	
	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.	Elevation gauge 2.	Corresponding elevation water surface.
1902.																				
Oct. 27	600.92	600.87	600.91	601.18	600.91	600.11	600.92	600.81	600.92	600.78	600.92	599.63	600.92	599.63	600.92	599.27	600.92	598.99	600.92	599.05
27	.93	.85	.93	.18	.93	.16	.93	.67	.94	.84	.95	.33	.95	.61	.94	.76	.94	.89	--------	--------
27	601.02	601.01	601.01	.48	601.01	.21	601.01	.91	601.00	.97	601.00	.53	.99	.53	.99	.31	.99	.89	.97	.00
27	600.98	600.96	600.98	.33	600.98	.18	600.97	.93	600.97	.82	600.96	.65	.96	.51	.96	.31	.96	.91	--------	--------
28	.95	.96	.95	.23	.95	.11	.95	.81	.96	.77	.96	.43	.96	.51	.96	.27	.96	.99	.95	.00
28	.94	.89	.94	.28	.94	.16	.93	.71	.93	.70	.93	.43	.93	.46	.94	.31	.94	599.01	--------	--------
28	601.07	601.09	601.07	.43	601.07	.22	601.07	.93	601.08	601.07	601.09	.68	601.09	.77	601.09	.53	601.00	.14	601.07	.16
28	.02	600.98	.02	.38	.03	.06	.04	.86	.04	600.90	.04	.58	.04	.81	.05	.41	.07	.14	--------	--------
Nov. 7	600.86	.65	600.86	600.90	600.87	.01	600.87	.66	600.86	.54	600.85	.33	600.85	.39	600.86	.16	600.86	598.83	600.85	598.85
8	.88	.87	.90	601.10	.92	.19	.93	.81	.94	.80	.94	.48	.93	.61	.93	.23	.90	.94	.88	599.02
8	.77	.63	.77	600.95	.76	599.98	.75	.59	.76	.52	.77	.26	.80	.46	.83	.20	.85	.98	--------	--------
8	.98	.96	.97	.78	.97	600.10	.96	.99	.94	.87	.93	.42	.92	.71	.90	.23	.89	.92	.87	598.96
8	.72	.53	.74	.85	.76	.01	.78	.67	.79	.50	.80	.42	.81	.34	.82	.31	.84	599.02	--------	--------

From similar data (see Table 5) the remaining stations were treated graphically and the relation of the variation of the water surface, as shown by section gauge 2 and the corresponding variation of the elevation of the water surface at the different discharge stations, has been deduced.

Table 6 gives the results.

TABLE 6.—*Variation of water surface in feet at discharge station per foot change of stage at section gauge 2, pier 2.*

Station.	Span 3.	Span 4.	Span 5.	Span 6.	Span 7.	Span 8.	Span 9.
1	1.00	1.00	1.79	1.57	1.00	1.00	1.00
2	1.69	1.43	1.93	1.86	1.39	2.01	1.00
3	1.64	1.43	1.93	2.06	1.67	1.36	------

The above results show very vividly the fact that the variations of stage are not always the same in midstream as determined by two gauges on opposite shores of a river.

The gauge records, velocity curves, and discharge observations were reduced according to the methods employed by Mr. F. C. Shenehon, assistant engineer, in the reduction of the Niagara River discharge measurements. (See Report Chief of Engineers, U. S. Army, 1900, p. 5326.)

Table 7 gives the results obtained in the 1902 gauge work.

TABLE 7.—*Summary daily mean gauge elevation.*

Date.	Daily mean gauge southwest pier.	Daily mean gauge No. 1.	Fall gauge southwest pier, to gauge No. 1.	Daily mean gauge No. 2.	Fall gauge 1 to gauge 2.	Daily mean gauge No. 3.	Fall gauge 1 to gauge 3.	Daily mean gauge No. 4.	Fall gauge 1 to gauge 4.
1902.									
July 24	----------	602.188	----------	600.952	+1.236	598.895	+3.293	----------	----------
25	----------	601.962	----------	.860	1.102	.806	3.156	602.147	−0.185
26	----------	602.263	----------	.962	1.241	.908	3.295	.378	.175
28	----------	.262	----------	.961	1.241	.895	3.307	.354	.152
31	----------	.312	----------	----------	----------	.955	3.357	.496	.184
Aug. 1	----------	.242	----------	.968	1.274	.911	3.331	.402	.160
2	----------	.110	----------	.917	1.193	.870	3.240	.295	.185
4	----------	.244	----------	.960	1.284	.921	3.323	.407	.163
5	----------	.481	----------	601.055	1.426	599.025	3.456	.629	.148
6	----------	.412	----------	.038	1.374	.005	3.407	.576	.164
7	----------	.205	----------	600.949	1.256	598.912	3.293	.368	.163
8	----------	.510	----------	601.090	1.420	599.045	3.465	.684	.174
9	----------	.053	----------	600.877	1.176	598.859	3.194	.222	.169
11	----------	[illegible]	----------	601.121	1.468	599.082	3.507	----------	----------
12	----------	[illegible]	----------	600.926	1.239	598.870	3.295	----------	----------
13	----------	.118	----------	.904	1.214	.864	3.254	----------	----------
14	----------	.340	----------	.998	1.342	.937	3.403	.511	.171
15	----------	.263	----------	.957	1.306	.934	3.329	.424	.161
16	----------	.250	----------	.965	1.285	.912	3.338	.412	.162
18	----------	.068	----------	.886	1.182	.855	3.213	.221	.153
19	----------	.249	----------	.952	1.297	.932	3.317	.405	.156
20	----------	.249	----------	.954	1.295	.915	3.334	.402	.153
21	----------	.371	----------	601.015	1.356	.968	3.403	----------	----------
22	----------	.331	----------	600.994	1.337	.946	3.385	.467	.136
23	----------	.292	----------	.974	1.318	.933	3.359	.428	.136
25	----------	.139	----------	.910	1.229	.861	3.278	.263	.124
26	----------	.342	----------	601.005	1.337	.953	3.489	.470	.138
27	----------	.208	----------	600.948	1.260	.889	3.319	.347	.139
28	----------	.054	----------	.876	1.178	.826	3.228	.177	.123
29	----------	.016	----------	.862	1.154	.809	3.207	.146	.130
30	----------	.089	----------	.892	1.197	.833	3.256	.212	.123
Sept. 2	----------	.297	----------	.975	1.322	.942	3.355	.417	.120
4	----------	.661	----------	601.135	1.526	599.086	3.575	.765	.104
6	----------	.267	----------	600.963	1.304	598.919	3.348	.400	.133
8	----------	.370	----------	601.002	1.368	.963	3.407	.489	.119
9	----------	.645	----------	.136	1.509	599.056	3.589	.755	.110
10	----------	.118	----------	600.921	1.197	598.858	3.260	.237	.119
11	----------	.547	----------	601.106	1.441	599.137	3.410	.663	.116
12	----------	.402	----------	.042	1.360	.080	3.322	.526	.124
13	----------	.537	----------	.103	1.434	.104	3.433	.654	.117
15	----------	.152	----------	600.935	1.217	598.967	3.185	.269	.117

TABLE 7.—*Summary daily mean gauge elevation*—Continued.

Date.	Daily mean gauge southwest pier.	Daily mean gauge No. 1.	Fall gauge southwest pier, to gauge No. 1.	Daily mean gauge No. 2.	Fall gauge 1 to gauge 2.	Daily mean gauge No. 3.	Fall gauge 1 to gauge 3.	Daily mean gauge No. 4.	Fall gauge 1 to gauge 4.
1902.									
Sept. 16	....	601.975	....	600.869	1.106	598.884	3.091	602.103	0.128
17	601.998	.985	+0.013	.874	1.111	.852	3.133	.114	.129
18	602.510	602.485	.025	601.082	1.403	599.135	3.350	.615	.130
19	.282	.273	.009	600.993	1.280	.020	3.253	.397	.124
20	.139	.131	.008	.932	1.199	598.988	3.143	.251	.120
22	.304	.289	.015	.987	1.302	599.084	3.205	.418	.129
23	.406	.385	.021	601.041	1.344	.088	3.297	.514	.129
24	.102	.102	.000	600.910	1.182	598.931	3.171	.230	.128
25	601.973	601.956	.017	.849	1.107	.898	3.058	.086	.130
26	602.070	602.036	.034	.884	1.152	.839	3.197	.165	.129
27	.171	.148	.023	.934	1.214	.939	3.209	.281	.133
29	.150	.142	.008	.923	1.219	.957	3.185	.279	.137
30	.587	.578	.009	601.100	1.478	599.122	3.456	.704	.126
Oct. 3	....	.306	....	600.998	1.308	.015	3.291	.452	.146
4	....	.164	....	.937	1.227	598.954	3.210	.303	.139
6	....	.413	....	601.036	1.377	599.033	3.380	.555	.142
7	....	.666	....	.140	1.526	.123	3.543	.789	.123
8	....	.365	....	.020	1.345	598.964	3.401	.495	.130
9	....	.171	....	600.940	1.231	.924	3.247	.301	.130
10	....	601.908	....	.822	1.076	.843	3.065	.047	.139
11	....	602.246	....	.972	1.274	.978	3.268	.378	.132
13	....	.384	....	601.023	1.361	599.021	3.363	.515	.131
14	....	.058	....	600.886	1.172	598.927	3.131	.188	.130
15	....	.486	....	601.072	1.414	599.145	3.341	.619	.133
16	....	.122	....	600.920	1.202	598.933	3.189	.249	.127
17	....	601.784	....	.769	1.015	.821	2.963	601.923	.139
18	....	.980	....	.855	1.125	.857	3.123	602.111	.131
20	....	602.320	....	.984	1.336	599.007	3.313	.447	.127
21	....	601.854	....	.803	1.051	598.797	3.057	601.990	.136
22	....	.963	....	.864	1.099	.816	3.147	602.094	.131
23	....	.490	....	.619	0.871	.621	2.869	601.632	.142
24	....	602.678	....	601.140	1.538	599.090	2.588	602.813	.135
25	....	601.729	....	600.741	0.988	598.734	2.995	601.853	.124
27	....	602.329	....	.995	1.334	.976	3.353	602.439	.110
28	....	.398	....	601.028	1.370	599.011	3.387	.500	.102
29	....	601.939	....	600.883	1.106	598.855	3.084	.056	.117
30	....	602.588	....	601.095	1.493	599.066	3.522	.715	.127
31	....	601.911	....	600.818	1.093	598.782	3.129	.035	.124
Nov. 6	....	602.585	....	601.101	1.484	599.048	3.537	....	....
7	....	.049	....	600.886	1.163	598.834	3.215	....	....
8	....	601.951	....	.837	1.114	.775	3.176	....	....

The reduction of the gauge relations for the normal and abnormal efflux conditions has been obtained by referring all comparisons to the U. S. Lake Survey automatic gauge, which has been in continuous operation since October, 1899. This gauge is located on the west end of the south pier of the American Ship Canal, about 2,000 feet above the section.

The following Table 8 gives the gauge relations as deduced:

TABLE 8.—*Gauge relations.*

Elevation automatic gauge.	Elevation gauge 1.	Fall from automatic guage.	Elevation gauge 2.	Fall from automatic gauge.	Elevation gauge 3.	Fall from automatic gauge.	Elevation gauge 4.	Fall from automatic gauge.	Elevation gauge 5.	Fall from automatic gauge.
1899.										
601.10	600.90	0.20	--------	--------	--------	--------	--------	--------	--------	--------
.30	601.10	.20	--------	--------	--------	--------	--------	--------	--------	--------
.50	.30	.20	--------	--------	--------	--------	--------	--------	--------	--------
.70	.50	.20	--------	--------	--------	--------	--------	--------	--------	--------
.90	.70	.20	--------	--------	--------	--------	--------	--------	--------	--------
602.10	.90	.20	--------	--------	--------	--------	--------	--------	--------	--------
.30	602.10	.20	--------	--------	--------	--------	--------	--------	--------	--------
.50	.30	.20	--------	--------	--------	--------	--------	--------	--------	--------
.70	.50	20	--------	--------	--------	--------	--------	--------	--------	--------
.90	.70	.20	--------	--------	--------	--------	--------	--------	--------	--------
603.10	.90	.20	--------	--------	--------	--------	--------	--------	--------	--------
JULY, 1901.										
601.10	601.00	−0.10	600.40	−0.70	599.53	−1.57	601.10	0.00	601.13	+0.03
.30	.20	.10	.53	.77	.67	.63	.30	.00	.33	.03
.50	.40	.10	.65	.85	.82	.68	.50	.00	.53	.03
.70	.60	.10	.78	.92	.96	1.74	.70	.00	.73	.03
.90	.80	.10	.90	1.00	600.10	1.80	.90	.00	.93	.03
602.10	602.00	.10	601.03	1.07	.23	1.87	602.10	.00	602.13	.03
.30	.20	.10	.15	1.15	.36	1.94	.30	.00	.33	.03
.50	.40	.10	.27	1.23	.49	2.01	.50	.00	.54	.04
.70	.60	.10	.38	1.32	.62	2.08	.70	.00	.74	.04
.90	.80	.10	.48	1.42	.74	2.16	.90	.00	.94	.04
603.10	603.00	.10	.58	1.52	.87	2.23	603.10	.00	603.14	.04
1902.										
601.27	601.25	−0.02	600.49	−0.78	598.47	−2.80	601.38	+0.11	--------	--------
.47	.45	.02	.60	.87	.58	2.89	.58	.11	--------	--------
.67	.65	.02	.70	.97	.69	2.98	.78	.11	--------	--------
.87	.85	.02	.80	1.07	.79	3.08	.98	.11	--------	--------
602.07	602.05	.02	.89	1.18	.88	3.19	602.18	.11	--------	--------
.27	.25	.02	.97	1.30	.96	3.31	.38	.11	--------	--------
.47	.45	.02	601.05	1.42	599.04	3.43	.58	.11	--------	--------
.67	.65	.02	.13	1.54	.12	3.55	.78	.11	--------	--------
.87	.85	.02	.21	1.66	.20	3.67	.98	.11	--------	--------
603.02	603.00	.02	.26	1.76	.25	3.77	603.13	.11	--------	--------

Plate 6 shows the fall between the U. S. Lake Survey automatic gauge and the various gauges in use. The elevation of the former is platted as ordinates and the fall to the different gauges as abscissas.

From this plate it is seen that gauges Nos. 1, 4, and 5, vary almost directly as the stage of the automatic gauge, and the fall increases for rising stage for gauges Nos. 2 and 3.

The normal discharge of the St. Marys Rapids, or the discharge before spans 9 and 10 had been shut off, was reduced from 33 measurements made in December, 1899, by Asst. Engineer Thomas Russell, using, in conjunction with these observations, the 1899 water surface data, the 1901 normal velocity coefficients, and the 1902 cross-section soundings.

Table 9 is a summary of the normal discharge measurements of the St. Marys Rapids.

TABLE 9.—*Summary, normal discharges, bridge section, St. Marys River.*

Reference No. of measurement.	Date.	Meter.	Elevation of water surface above mean tide at New York.			Fluctuation of automatic gauge SW. pier during measurement.		Wind.		Discharge per second.
			Automatic gauge SW. pier.	Gauge II.	Fall.	Rise.	Fall.	Direction.	Approximate velocity per hour.	
	1899.								*Miles.*	*Cu. feet.*
1	Dec. 4	8 B	602.64	601.29	1.35	0.08	0.19	----------	----------	83,000
2	Dec. 5	8 B	.51	.21	1.30	.09	.09	----------	----------	81,680
3	Dec. 6	8 B	.38	.14	1.24	.04	.11	0	0	78,940
4	Dec. 9	8 B	601.59	600.64	0.95	.20	.30	E.	(12-15)	67,360
5	....do	8 B	.68	.70	0.98	.16	.17	E.	(12-15)	68,790
6	Dec. 11	8 B	602.43	601.16	1.27	.13	.30	NE.	(2- 4)	80,660
7	Dec. 12	8 B	.32	.10	1.22	.14	.10	SE.	(2- 4)	78,620
8	....do	8 B	.66	.30	1.36	.07	.21	SW.	(2- 4)	82,800
9	....do	8 B	.62	.28	1.34	.25	.25	SW.	----------	82,640
10	Dec. 13	8 B	.54	.23	1.31	.09	.08	N.	(2- 4)	81,440
11	....do	8 B	.55	.24	1.31	.05	.10	NW.	(2- 4)	80,560
12	Dec. 14	8 B	.20	.03	1.17	.02	.07	NE.	(2- 4)	77,460
13	....do	8 B	.10	600.96	1.14	.10	.07	NE.	(2- 4)	74,660
14	Dec. 15	8 B	.27	601.07	1.20	.28	.13	SE.	(2- 4)	77,560
15	....do	8 B	.48	.20	1.28	.07	.08	E.	(2- 4)	80,030
16	Dec. 16	8 B	.23	.04	1.19	.11	.14	SE.	(2- 4)	77,000
17	....do	8 B	.33	.11	1.22	.03	.11	E.	(2- 4)	77,910
18	Dec. 18	8 B	601.96	600.88	1.08	.26	.08	E.	(2- 4)	72,780
19	Dec. 19	8 B	603.19	601.58	1.61	.18	.30	NW.	(12-15)	89,420
20	....do	8 B	602.59	.26	1.33	.44	.12	NW.	(12-15)	81,560
21	Dec. 20	8 B	.20	.03	1.17	.04	.05	SW.	(2- 4)	75,320
22	....do	8 B	.44	.17	1.27	.11	.25	SW.	(2- 4)	79,590
23	....do	8 B	.22	.04	1.18	.28	.09	SW.	(2- 4)	76,480
24	Dec. 21	8 B	.24	.05	1.19	.27	.16	NW. 0	(1- 0)	76,560
25	....do	8 B	.65	.30	1.35	.08	.27	NW.	(5- 7)	81,840
26	....do	8 B	.51	.21	1.30	.14	.14	NW.	(2- 4)	80,480
27	Dec. 22	8 B	.11	600.97	1.14	.16	.29	E.	(2- 4)	74,020
28	....do	8 B	601.85	.81	1.04	.18	.05	E.	(8-10)	71,320
29	....do	8 B	.94	.86	1.08	.29	.17	SE.	(2- 4)	73,320
30	Dec. 23	8 B	602.16	601.00	1.16	.04	.04	SE.	(2- 4)	75,580
31	....do	8 B	.28	.08	1.20	.05	.08	SE.	(2- 4)	76,640
32	Dec. 27	8 B	.45	.18	1.27	.21	.05	SW.	(5- 7)	78,780
33	....do	8 B	.52	.22	1.30	.03	.04	SW.	(12-15)	79,680

The following equation has been deduced by a least square adjustment of the observations:

Normal discharge, St. Marys Rapids=13910 (U. S. Lake Survey automatic gauge, Southwest Canal pier, −600)+45620.

This curve should be used with caution for greater variations of stage than shown in the observations. The probable error of a single measurement for mean gauge is 410 cubic feet per second; the probable error of the result for mean gauge is 71 cubic feet per second, and the probable error of the increment is 232 cubic feet per second. The above probable errors do not take into account the probable errors of the meter ratings, gauge readings, cross section and velocity coefficients, but is simply the internal consistency of the discharge measurements.

The abnormal discharge of the St. Marys Rapids, or the discharge after spans 9 and 10 had been blocked by partially damming the river, was reduced from the 149 measurements made by the writer, using in conjunction the 1902 soundings, water-surface measurements, and velocity coefficients.

Table 10 gives a complete summary of the abnormal measurements.

TABLE 10.—*Summary, abnormal discharges, bridge section, St. Marys River.*

Reference No. of measurement.	Date.	Meter.	Rating No. of meter (see Table 4).	Elevation of water surface above mean tide at New York.			Fluctuation of guage No. 2 during measurement.		Wind.		Discharge per second.
				Automatic gauge SW. pier.	Gauge II.	Fall.	Rise.	Fall.	Direction.	Approximate velocity per hour.	
	1902.									*Miles.*	*Cu. feet.*
1	July 31	3 B	1	602.52	601.08	1.44	0.06	0.13	W.	8	73,760
2	Aug. 1	3 B	1	.40	.03	1.37	.07	.07	NE.	2	71,910
3	....do....	3 B	1	.25	600.96	1.29	.12	.11	S., SW.	2	69,610
4	....do....	3 B	1	.32	.99	1.33	.04	.04	W.	6	69,630
5	....do....	3 B	1	.30	.98	1.32	.02	.02	W.	7	69,440
6	Aug. 2	3 B	1	.25	.96	1.29	.03	.14	SE., SW.	2	68,990
7	....do....	3 B	1	.10	.90	1.20	.03	.05	W., SW.	6	66,600
8	Aug. 4	3 B	1	.52	601.08	1.44	.01	.06	NE., W.	5	73,720
9	....do....	3 B	1	.05	600.88	1.17	.08	.05	W.	4	66,160
10	....do....	3 B	1	.03	.87	1.16	.07	.04	W., N.	3	65,210
11	Aug. 5	3 B	1	.42	601.04	1.38	.04	.02	SE., S.	2	71,540
12	....do....	3 B	1	.58	.10	1.48	.02	.03	S.	3	73,240
13	....do....	3 B	1	.42	.04	1.38	.02	.03	NW.	11	71,800
14	....do....	3 B	1	.20	600.94	1.26	.07	.09	NW.	18	68,170
15	Aug. 6	3 B	1	.38	601.02	1.36	.03	.05	NW.	14	70,960
16	....do....	3 B	1	.52	.08	1.44	.07	.03	NW.	14	73,060
17	....do....	3 B	1	.35	.01	1.34	.01	.01	NW.	17	70,420
18	....do....	3 B	1	.32	600.99	1.33	.02	.02	NW.	17	69,710
19	Aug. 7	3 B	1	.25	.96	1.29	.04	.06	SE., S.	3	68,330
20	....do....	3 B	1	.30	.98	1.32	.03	.04	S.	5	68,860
21	....do....	3 B	1	.30	.98	1.32	.03	.04	SW.	8	69,270
22	....do....	3 B	1	.10	.90	1.20	.03	.02	S.	10	66,190
23	Aug. 8	3 B	1	.68	601.14	1.54	.03	.02	NW., W.	18	75,560
24	....do....	3 B	1	.68	.14	1.54	.01	.02	W., NW.	20	75,250
25	....do....	3 B	1	.48	.06	1.42	.01	.01	NW.	19	71,660
26	....do....	3 B	1	.45	.05	1.40	.02	.03	W., NW.	18	71,070
27	Aug. 9	3 B	1	.08	600.89	1.19	.01	.02	NW., E.	3	66,730
28	....do....	3 B	1	.22	.95	1.27	.02	.05	SE.	8	68,820
29	Aug. 11	3 B	1	.60	601.11	1.49	.04	.04	NW.	21	73,200
30	....do....	3 B	1	.80	.18	1.62	.02	.03	NW.	23	76,530
31	....do....	3 B	1	.50	.07	1.43	.07	.04	NW.	26	70,090
32	....do....	3 B	1	.75	.16	1.59	.01	.02	NW.	28	74,240
33	Aug. 12	3 B	1	.22	600.95	1.27	.02	.02	S., SW.	2	68,400
34	....do....	3 B	1	.22	.95	1.27	.02	.02	SW.	4	68,220
35	....do....	9 B	8	601.98	.85	1.13	.05	.04	W.	6	63,160
36	....do....	9 B	8	602.25	.96	1.29	.04	.04	W., SW.	7	66,520
37	Aug. 13	9 B	8	.25	.96	1.29	.02	.03	E.	4	68,870
38	Aug. 23	9 B	8	.25	.96	1.29	.03	.04	NW.	12	69,130
39	....do....	9 B	8	.28	.97	1.31	.05	.05	W.	12	69,720
40	Aug. 25	9 B	8	.20	.94	1.26	.05	.04	W.	10	68,880
41	Aug. 26	9 B	8	.33	601.00	1.33	.04	.10	NW.	1	69,310
42	Aug. 27	9 B	8	.12	600.91	1.21	.06	.06	E.	2	64,420
43	....do....	9 B	8	.22	.95	1.27	.02	.04	E., SE.	4	66,460
44	Sept. 2	9 B	8	.42	601.04	1.38	.04	.04	W.	5	70,330
45	....do....	9 B	8	.20	600.94	1.26	.08	.04	W.	7	67,590
46	....do....	9 B	8	.10	.90	1.20	.03	.04	SW., NW.	9	64,910
47	Sept. 4	3 B	2	.60	601.11	1.49	.02	.02	NW.	16	71,860
48	....do....	3 B	2	.68	.14	1.54	.02	.01	NW.	21	74,850
49	....do....	3 B	2	.72	.16	1.56	.03	.03	NW.	23	75,150
50	....do....	3 B	2	.85	.20	1.65	.01	.03	NW.	24	77,590
51	Sept. 6	3 B	3	.12	600.91	1.21	.09	.05	SW., S.	16	64,750
52	....do....	3 B	3	.38	601.02	1.36	.02	.02	SW.	14	68,160
53	Sept. 9	9 B	11	.75	.16	1.59	.02	.02	NW.	22	75,850
54	....do....	9 B	11	.75	.16	1.59	.04	.02	NW.	19	74,690
55	Sept. 10	9 B	11	.28	600.97	1.31	.09	.08	SW.	18	70,460
56	Sept. 13	9 B	11	.68	601.14	1.54	.02	.03	NW.	20	77,510
57	Sept. 15	9 B	11	.20	600.94	1.26	.02	.02	SE.	2	70,080
58	....do....	9 B	11	.22	.95	1.27	.02	.01	SE., S.	3	70,460
59	Sept. 16	9 B	11	601.85	.79	1.06	.05	.01	SE.	5	63,780
60	....do....	9 B	11	602.10	.90	1.20	.06	.09	S.	7	67,540
61	....do....	9 B	11	601.92	.82	1.10	.07	.03	S., SE.	10	63,670
62	....do....	9 B	11	.95	.83	1.12	.07	.06	SE.	10	63,640
63	Sept. 17	9 B	11	.90	.81	1.09	.02	.07	E., SE.	5	64,010
64	....do....	9 B	11	602.08	.89	1.19	.04	.09	SE.	8	67,280
65	....do....	9 B	11	601.82	.78	1.04	.13	.05	SE., S.	12	63,600
66	....do....	9 B	11	602.05	.88	1.17	.12	.11	SE., S.	12	67,270
67	Sept. 19	9 B	11	.25	.96	1.29	.02	.02	E.	12	68,640
68	....do....	9 B	11	.25	.96	1.29	.03	.02	E.	8	69,830
69	Sept. 20	9 B	11	.10	.90	1.20	.03	.03	E.	5	66,770
70	....do....	9 B	11	.32	.99	1.33	.03	.06	E.	6	71,640
71	....do....	9 B	11	.10	.90	1.20	.01	.05	SE.	6	67,300
72	....do....	9 B	11	.15	.92	1.23	0.01	0.03	SE.	6	68,540
73	Sept. 22	9 B	11	.33	601.00	1.33	.02	.04	0, SW.	4	71,800
74	....do....	9 B	11	.30	600.98	1.32	.03	.03	SW.	3	71,280
75	....do....	9 B	11	.38	601.02	1.36	.01	.04	SW.	2	71,890

TABLE 10.—*Summary, abnormal discharges, bridge section, St. Marys River*—Continued.

Reference No. of measurement.	Date.	Meter.	Rating No. of meter (see Table 4).	Elevation of water surface above mean tide at New York.			Fluctuation of gauge No. 2 during measurement.		Wind.		Discharge per second.
				Automatic gauge SW. pier.	Gauge II.	Fall.	Rise.	Fall.	Direction.	Approximate velocity per hour.	
	1902.									*Miles.*	*Cu. feet.*
76	Sept. 22	9 B	11	602.22	600.95	1.27	0.05	0.02	SW.	3	69,760
77	Sept. 23	9 B	11	.45	601.05	1.40	.02	.04	W., NW.	7	74,040
78	....do...	9 B	11	.28	600.97	1.31	.04	.02	NW.	8	71,670
79	....do...	9 B	11	.38	601.02	1.36	.03	.02	NW.	13	71,760
80	....do...	9 B	11	.50	.07	1.43	.03	.02	NW., W.	12	74,620
81	Sept. 24	9 B	11	601.96	600.84	1.12	.06	.03	E.	10	64,160
82	....do...	9 B	11	602.00	.86	1.14	.04	.03	E.	10	65,600
83	....do...	9 B	11	.20	.94	1.26	.01	.02	SE.	7	68,180
84	....do...	9 B	11	.20	.94	1.26	.01	.01	SE.	6	67,830
85	Sept. 25	9 B	11	601.98	.85	1.13	.05	.02	E.	10	67,240
86	....do...	9 B	11	.90	.81	1.09	.02	.03	SE.	11	65,620
87	....do...	9 B	11	602.05	.88	1.17	.05	.05	SE.	13	65,270
88	....do...	3 B	5	601.95	.83	1.12	.01	.02	E.	13	63,000
89	Sept. 26	3 B	5	602.18	.93	1.25	.03	.05	E., SE.	4	66,740
90	....do...	3 B	5	601.95	.83	1.12	.02	.02	SE.	7	62,630
91	....do...	3 B	5	602.02	.87	1.15	.04	.03	SE.	6	63,960
92	....do...	3 B	5	.02	.87	1.15	.03	.03	SE., E.	5	64,150
93	Sept. 27	3 B	5	.18	.93	1.25	.09	.03	S., SE.	5	66,150
94	....do...	3 B	5	601.92	.82	1.10	.06	.01	SE.	5	61,540
95	....do...	3 B	5	.92	.82	1.10	.14	.03	E.	5	62,270
96	....do...	3 B	5	602.28	.97	1.31	.05	.07	E.	5	67,010
97	Sept. 29	3 B	5	.25	.96	1.29	.01	.02	NW.	3	66,230
98	....do...	3 B	5	.25	.96	1.29	.01	.02	NW.	3	66,250
99	....do...	3 B	5	.15	.92	1.23	.03	.03	W.	5	65,970
100	....do...	3 B	5	.12	.91	1.21	.02	.03	W., SE.	3	65,760
101	Sept. 30	3 B	5	.52	601.08	1.44	.02	.02	SE.	1	70,010
102	....do...	3 B	5	.75	.16	1.59	.05	.08	SE.	6	74,780
103	....do...	3 B	5	.25	600.96	1.29	.07	.04	W., NW.	15	66,440
104	....do...	3 B	5	.65	601.13	1.52	.03	.07	NW.	17	74,880
105	Oct. 3	9 B	14	.32	600.99	1.33	.03	.01	NW.	2	72,900
106	....do...	9 B	14	.35	601.01	1.34	.02	.03	NW.	9	72,780
107	Oct. 4	9 B	14	.28	600.97	1.31	.02	.03	NW., E.	4	70,300
108	....do...	9 B	14	.15	.92	1.23	.03	.02	E.	3	68,980
109	Oct. 6	9 B	14	.20	94	1.26	.01	.01	SW.	2	70,210
110	....do...	9 B	14	.34	601.00	1.34	.02	.03	SW.	1	71,890
111	Oct. 16	9 B	14	.18	600.93	1.25	.01	.04	NW.	11	65,980
112	Oct. 17	9 B	14	601.78	.76	1.02	.05	.03	E.	5	63,090
113	Oct. 20	9 B	14	602.18	.93	1.25	.02	.02	NW.	18	65,200
114	....do...	9 B	14	.45	601.05	1.40	.07	.13	NW.	21	66,780
115	....do...	9 B	14	.34	.00	1.34	.02	.02	NW.	27	70,660
116	....do...	9 B	14	.35	.01	1.34	.02	.03	NW.	23	70,510
117	Oct. 21	9 B	14	601.78	600.76	1.02	.07	.06	N., NE., SE.	4	59,460
118	....do...	9 B	14	602.00	.86	1.14	.04	.04	SE., S., SW.	5	63,120
119	....do...	9 B	14	601.84	.78	1.06	.06	.03	SE.	8	59,550
120	....do...	9 B	14	.77	.75	1.02	.02	.03	SE.	9	58,890
121	Oct. 22	9 B	14	.90	.81	1.09	.02	.01	E.	6	63,570
122	....do...	9 B	14	.90	.81	1.09	.02	.02	E.	7	64,170
123	....do...	9 B	14	602.28	.97	1.31	.01	.03	E.	4	67,640
124	....do...	9 B	14	601.98	.85	1.13	.08	.05	NE.	5	63,120
125	Oct. 23	9 B	14	.62	.68	0.94	.05	.10	E.	10	57,950
126	....do...	9 B	14	.38	.55	0.83	.02	.04	E.	13	53,640
127	....do...	9 B	14	.48	.60	0.88	.15	.17	SE.	15	56,480
128	....do...	9 B	14	.16	.43	0.73	.11	.03	SE.	16	52,760
129	Oct. 24	9 B	14	602.50	601.07	1.43	.05	.09	SW.	12	72,510
130	....do...	9 B	14	.38	.02	1.36	.02	.05	NW.	20	69,420
131	....do...	9 B	14	.90	.22	1.68	.03	.01	W.	24	76,460
132	....do...	9 B	14	603.05	.27	1.78	.01	.07	W.	32	76,580
133	Oct. 25	9 B	14	601.92	600.82	1.10	.02	.04	NE.	7	63,380
134	....do...	9 B	14	.77	.75	1.02	.04	.02	E.	9	61,140
135	....do...	9 B	14	.68	.71	0.97	.05	.03	E.	11	59,240
136	....do...	9 B	14	.80	.77	1.03	.03	.07	E.	9	59,120
137	Oct. 27	9 B	14	602.18	.93	1.25	.10	.02	W.	15	67,400
138	....do...	9 B	14	.20	.94	1.26	.01	.01	SW.	14	68,540
139	....do...	9 B	14	.38	601.02	1.36	.04	.05	W.	15	68,440
140	....do...	9 B	14	.30	600.98	1.32	.03	.02	W.	15	68,920
141	Oct. 28	9 B	14	.28	.97	1.31	.06	.02	N.	6	68,660
142	....do...	9 B	14	.18	.93	1.25	.02	.01	NW.	10	65,960
143	....do...	9 B	14	.52	601.08	1.44	.02	.01	NW.	18	72,020
144	....do...	9 B	14	.42	.04	1.38	.03	.02	NW.	16	70,5[illegible]0
145	Nov. 7	9 B	16	.00	600.86	1.14	.05	.02	W., SE.	5	63,680
146	Nov. 8	9 B	16	.08	.89	1.19	.05	.09	S.	12	65,900
147	....do...	9 B	16	601.80	.77	1.03	.06	.03	S.	11	60,400
148	....do...	9 B	16	602.25	.96	1.29	.03	.09	SE.	6	69,340
149	....do...	9 B	16	601.78	.76	1.02	.10	.04	SE.	8	61,060

The same form of equation that was deduced from the normal measurements has been used in this case. In the reduction discharges Nos. 114 and 132 have been omitted on account of defective observations.

The discharge equation is as follows:

Abnormal discharge St. Marys Rapids = 15,540 (U. S. Lake Survey Automatic Gauge, Southwest Canal Pier + 33,570.

As mentioned under the normal equation, the curve should not be used beyond the extreme variation of stage shown in the observations.

The probable error of a single measurement for mean stage is 938 cubic feet per second; the probable error of the result for mean stage is 78 cubic feet per second, and the probable error of the increment is 276 cubic feet per second. The above probable errors refer only to the internal consistency of the measurements.

The normal and abnormal discharge measurements are shown graphically on Plate 24.

The percentage discharge through the different spans for normal and abnormal efflux conditions is as follows:

TABLE 11.

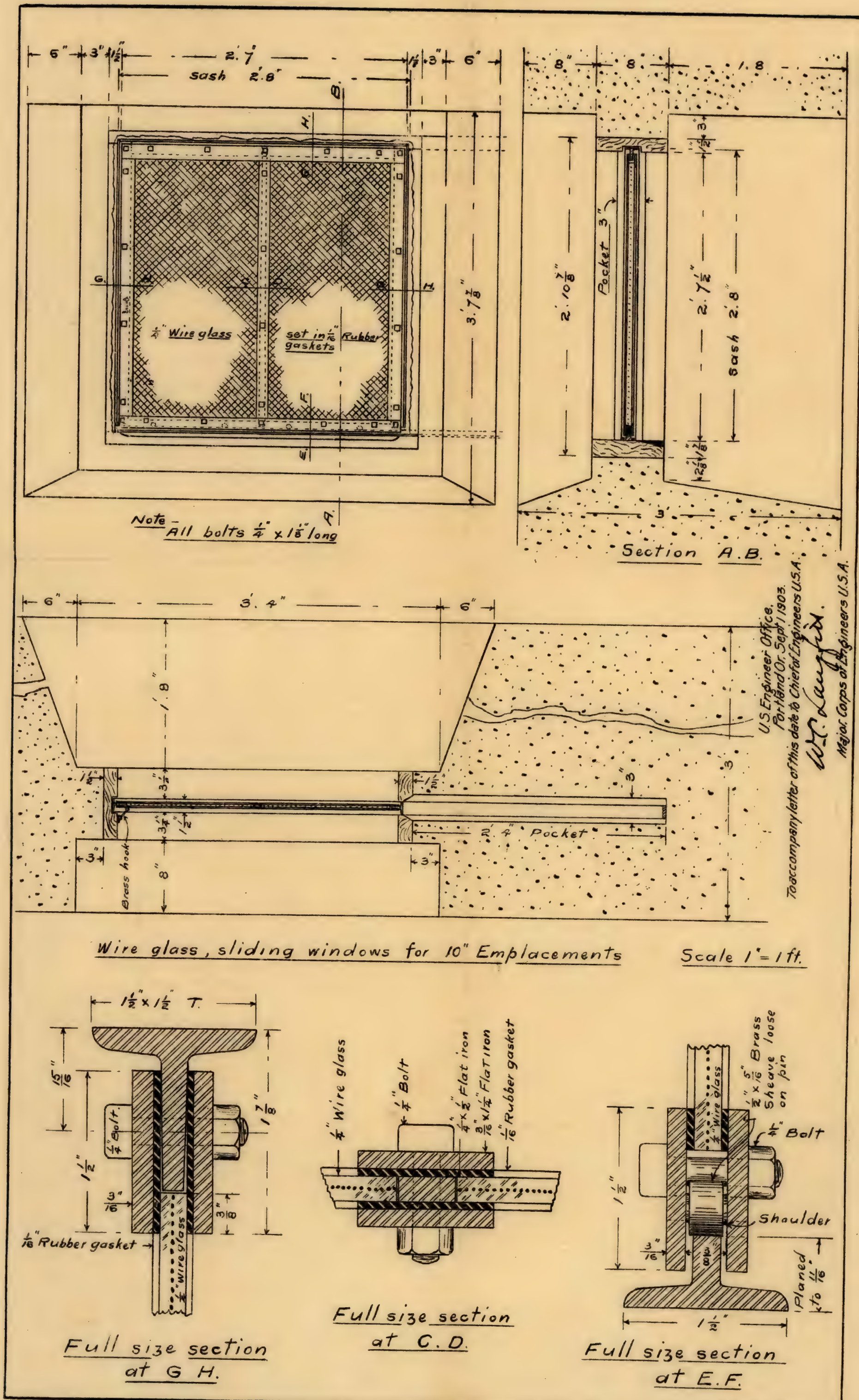
Span.	Normal flow.	Abnormal flow.	Difference.
	Per cent.	*Per cent.*	*Per cent.*
3	5.8	7.3	1.5
4	5.2	8.1	2.9
5	12.2	16.4	4.2
6	17.0	20.8	3.8
7	16.0	21.8	5.8
8	21.2	24.4	3.2
9	17.2	1.2	16.0
10	5.4	0.0	5.4

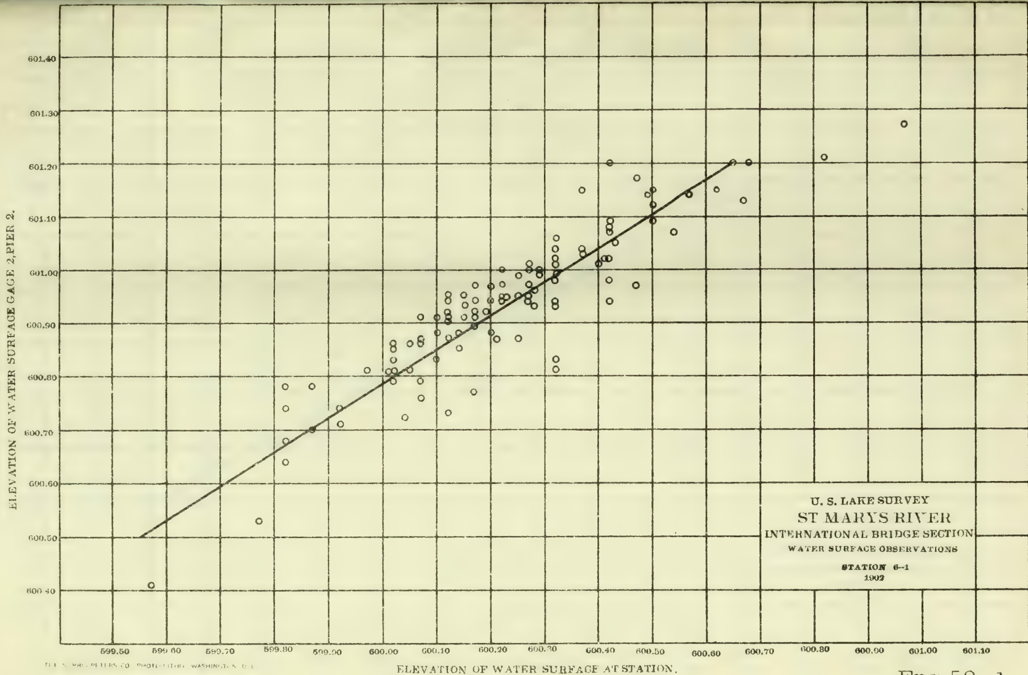
On Plates 7 to 23 inclusive are given the vertical velocity curves as observed at the several discharge stations.

The cross-section station areas and the mean velocity station coefficients for normal and abnormal flow are compared in Table 12.

TABLE 12.—CROSS-SECTION AREAS (SQUARE FEET), NORMAL FLOW.

Section height, in feet, above mean tide, New York.		Span 3.			Span 4.			Span 5.			Span 6.			Span 7.			Span 8.			Span 9.			Span 10.		
Gauge I.	Gauge II.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.	Station 1.	Station 2.	Station 3.
603.35	601.75	326	255	283	272	345	313	392	592	646	639	509	830	545	680	608	793	776	737	774	660	564	461	320	245
602.83	.50	306	237	265	252	327	295	372	574	628	619	491	812	525	662	590	775	758	719	754	642	546	443	302	227
.37	.25	286	218	246	232	308	276	352	555	609	599	472	793	505	643	571	756	739	700	734	623	529	426	285	210
601.96	.00	266	199	227	212	289	257	332	536	590	579	453	774	485	624	552	737	720	681	714	604	511	408	267	192
.56	600.75	246	180	208	192	270	238	312	517	571	559	434	755	465	605	533	718	701	662	694	585	493	390	249	174
.16	.50	226	161	189	172	251	219	292	498	552	539	415	736	445	586	514	699	682	643	674	566	476	373	232	157
....	.25	206	143	171	152	233	201	272	480	534	519	397	718	425	568	496	681	664	625	654	548	458	355	214	139
MEAN VELOCITY COEFFICIENTS, NORMAL FLOW.																									
603.35	601.75	0.851	0.935	0.842	0.687	0.907	0.660	0.737	0.873	0.683	0.728	0.913	0.855	0.790	0.887	0.880	0.891	0.884	0.861	0.840	0.881	0.870	0.845	0.667	0.640
602.83	.50	.855	.935	.842	.692	.907	.658	.739	.873	.684	.729	.913	.856	.788	.887	.881	.891	.884	.862	.841	.881	.869	.845	.666	.642
.37	.25	.862	.935	.842	.696	.907	.656	.742	.873	.684	.730	.913	.857	.787	.887	.882	.891	.884	.862	.842	.881	.869	.845	.665	.645
601.96	.00	.867	.935	.842	.701	.907	.654	.745	.872	.685	.731	.913	.858	.785	.888	.884	.891	.884	.862	.844	.881	.869	.846	.664	.649
.56	600.75	.873	.935	.842	.707	.907	.652	.748	.872	.685	.732	.913	.859	.783	.888	.885	.892	.884	.862	.845	.881	.868	.846	.663	.652
.16	.50	.879	.936	.842	.713	.907	.650	.751	.872	.685	.732	.913	.860	.782	.888	.886	.892	.884	.862	.846	.881	.868	.846	.662	.656
....	.25	.887	.936	.842	.720	.908	.647	.755	.872	.685	.733	.913	.861	.780	.888	.888	.892	.884	.863	.848	.881	.868	.846	.662	.659
CROSS-SECTION AREAS (SQUARE FEET), ABNORMAL FLOW.																									
....	601.75	293	400	327	......	692	327	458	742	634	628	746	674	451	799	603	586	777	653	663	401	......	......	......	......
....	.50	275	366	296	......	644	303	425	702	600	597	701	642	433	768	576	567	740	628	643	388	......	......	......	......
602.98	.25	256	332	265	......	596	279	392	662	566	566	656	610	415	737	549	549	703	603	623	375	......	......	......	......
.32	.00	238	298	234	......	548	255	360	622	532	535	611	578	397	706	522	530	666	578	603	363	......	......	......	......
601.75	600.75	220	264	203	......	500	231	328	582	498	504	566	546	379	675	495	511	629	553	583	351	......	......	......	......
.27	.50	201	230	172	......	452	207	295	542	464	473	521	514	361	644	468	493	592	528	563	338	......	......	......	......
....	.25	183	196	141	......	404	183	262	502	430	442	476	482	343	613	441	474	555	503	543	325	......	......	......	......
MEAN VELOCITY COEFFICIENTS, ABNORMAL FLOW.																									
....	601.75	0.777	0.950	0.841	......	1.091	0.928	0.857	0.858	0.892	0.819	0.896	0.867	0.776	0.932	0.980	0.736	0.848	0.686	0.376	0.489	......	......	......	......
....	.50	.782	.950	.841	......	1.093	.928	.858	.858	.892	.820	.896	.867	.778	.931	.980	.736	.848	.686	.375	.489	......	......	......	......
602.98	.25	.786	.950	.841	......	1.094	.928	.859	.858	.892	.822	.896	.867	.779	.931	.980	.736	.848	.686	.375	.488	......	......	......	......
.32	.00	.790	.950	.841	......	1.096	.928	.860	.858	.892	.823	.895	.867	.780	.930	.980	.736	.848	.686	.374	.488	......	......	......	......
601.75	600.75	.796	.950	.841	......	1.099	.927	.862	.858	.892	.825	.895	.867	.781	.930	.980	.736	.848	.686	.374	.488	......	......	......	......
.27	.50	.802	.950	.841	......	1.102	.927	.864	.858	.892	.827	.894	.867	.782	.929	.980	.736	.848	.685	.373	.488	......	......	......	......
....	.25	.809	.951	.841	......	1.105	.926	.865	.858	.892	.829	.894	.867	.784	.929	.980	.735	.848	.685	.373	.488	......	......	......	......

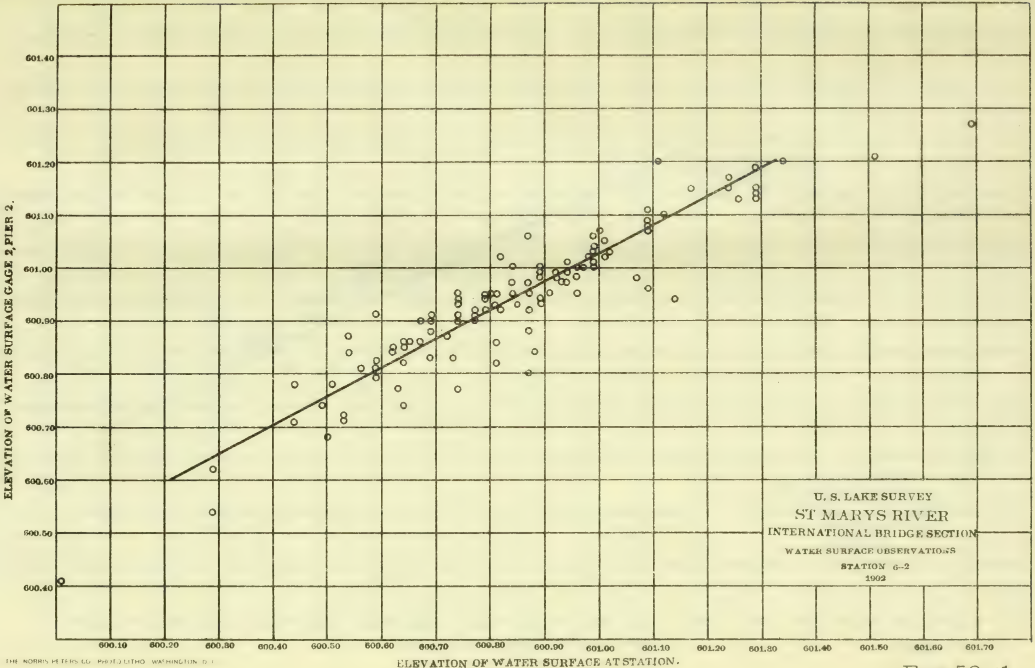

Wire glass, sliding windows for 10" Emplacements
Scale 1" = 1 ft.
sash 2'8"
1/4" Wire glass
set in 1/16" Rubber gaskets
Note - All bolts 1/4" x 1 1/8" long
Pocket 3"
sash 2'8"
Section A.B.
Pocket
Brass hook
US Engineer Office, Portland Or. Sept 1 1903.
To accompany letter of this date to Chief of Engineers U.S.A.
W. C. Langfitt
Major, Corps of Engineers U.S.A.
1 1/2" x 1 1/2" T.
1/4" Bolt
1/16" Rubber gasket
1/4" Wire glass
Full size section at G H.
1/4" Wire glass
1/4" Bolt
1/4" x 1/2" Flat iron
3/16" x 1/4" Flat iron
1/16" Rubber gasket
Full size section at C. D.
1/2" x 5/16" Brass Sheave loose on pin
1/4" Bolt
Shoulder
Planed to 11/16
Full size section at E.F.
ANDREW B GRAHAM, PHOTO-LITHO WASHINGTON D.C.



THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

Eng 58 1

PLATE No 4.



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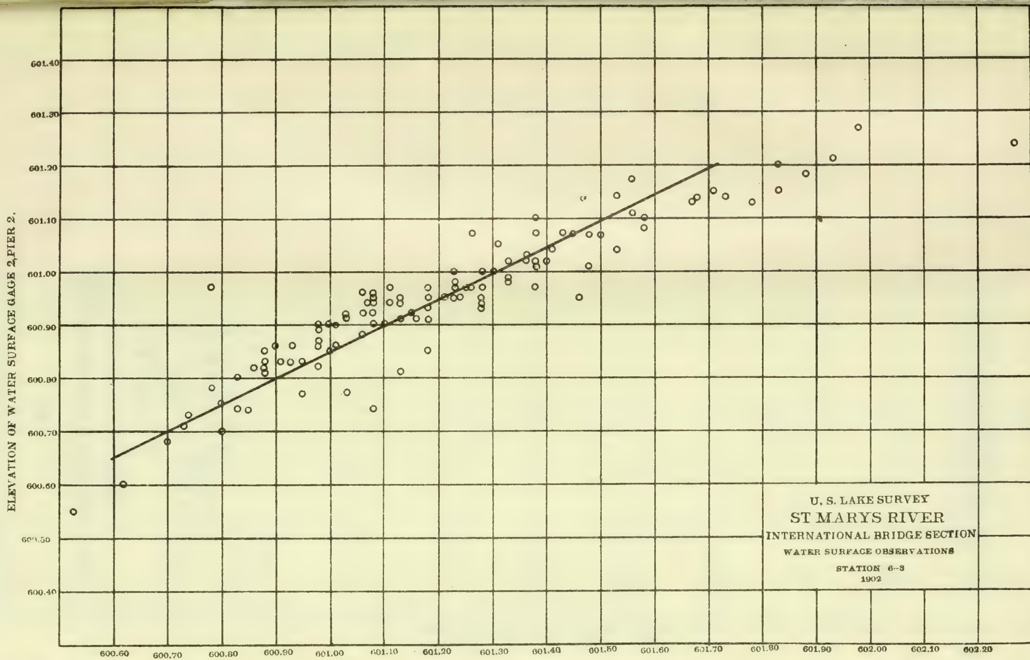
Eng 58 1



ELEVATION OF WATER SURFACE AT STATION.

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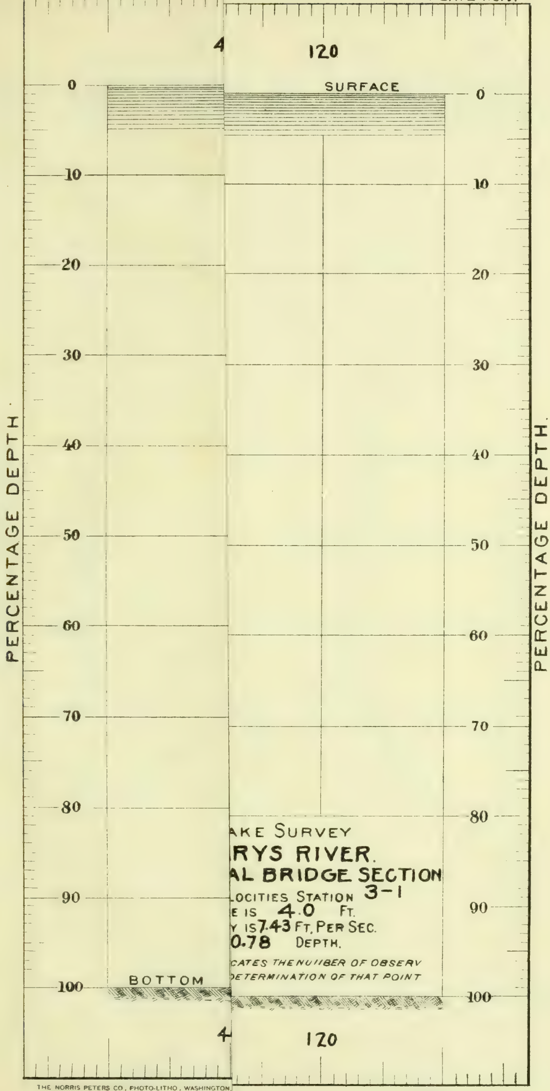
Eng 58 1

PLATE No. 7.



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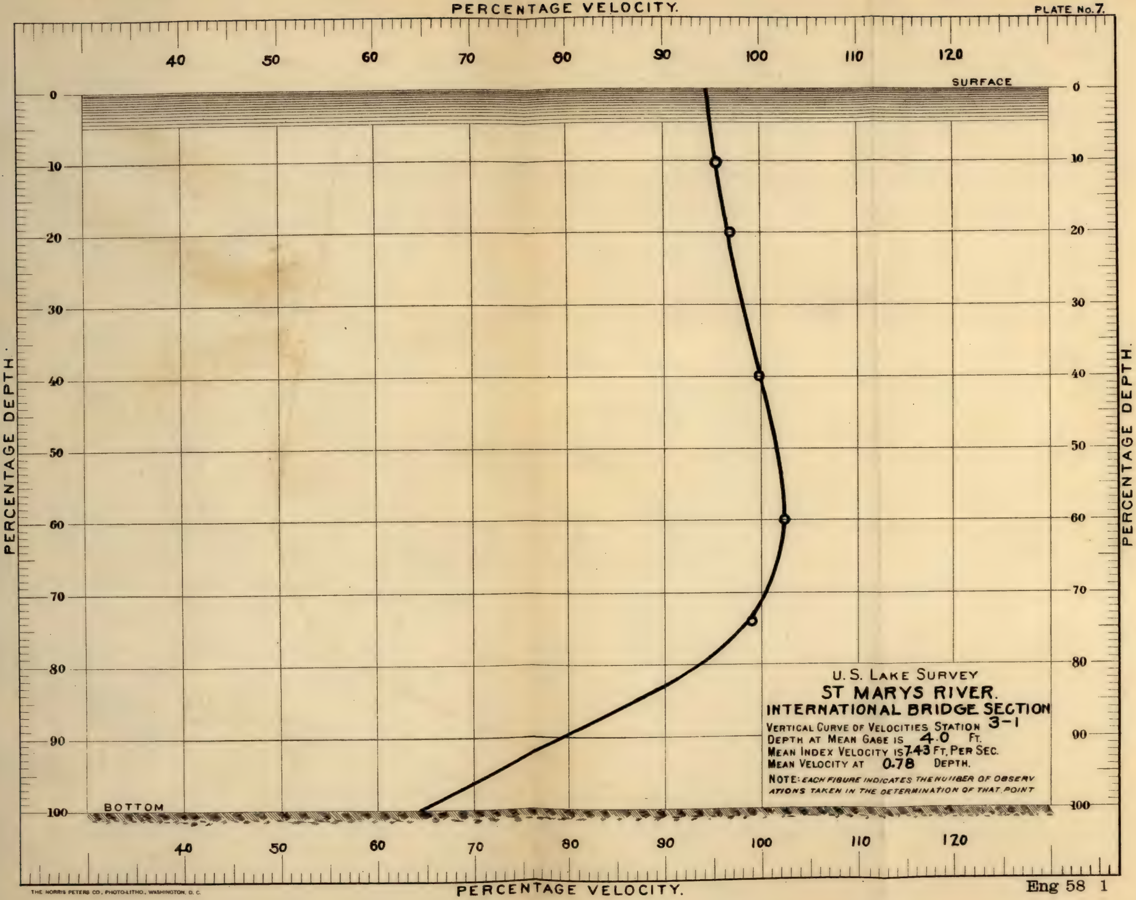
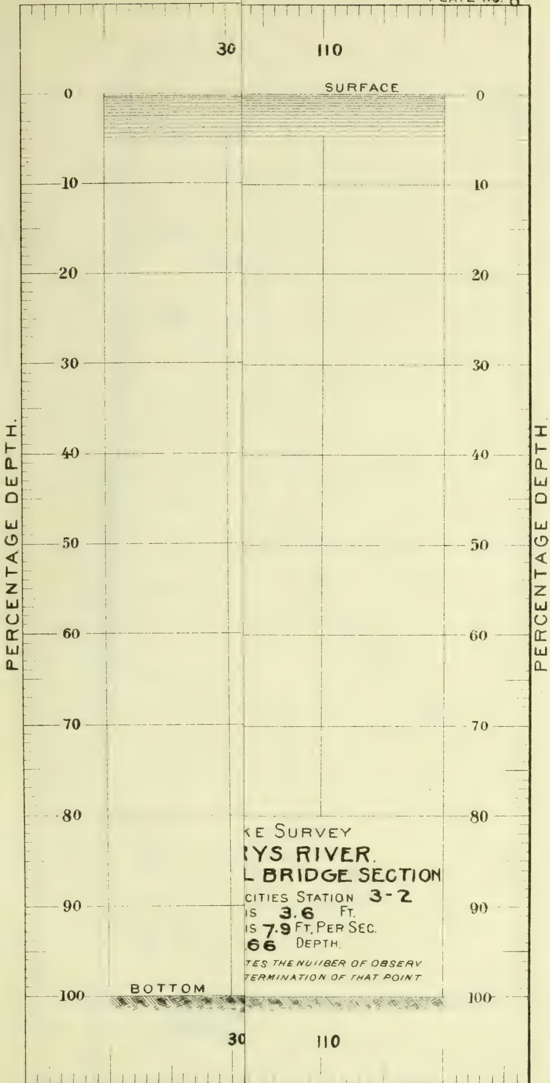

PERCENTAGE VELOCITY.
40
50
60
70
80
90
100
110
120
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 3-1
DEPTH AT MEAN GAGE IS 4.0 FT.
MEAN INDEX VELOCITY IS 7.43 FT. PER SEC.
MEAN VELOCITY AT 0.78 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT

PLATE No. 8



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D

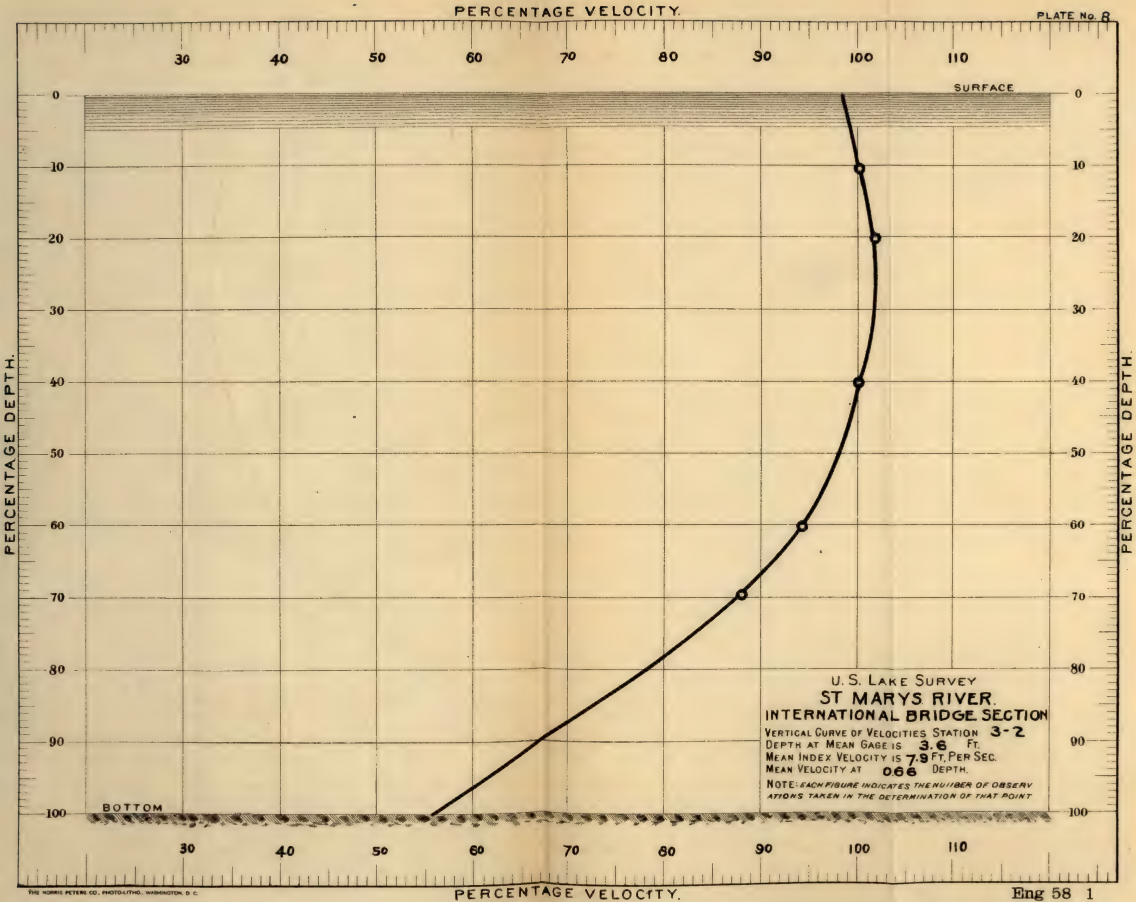
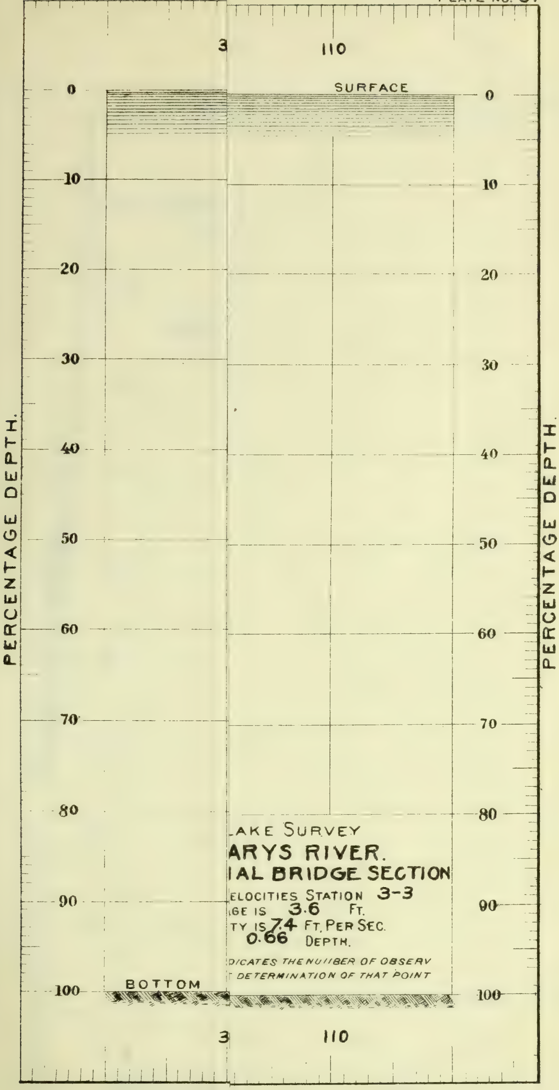

PERCENTAGE VELOCITY.
30
40
50
60
70
80
90
100
110
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 3-2
DEPTH AT MEAN GAGE IS 3.6 FT.
MEAN INDEX VELOCITY IS 7.9 FT. PER SEC.
MEAN VELOCITY AT 0.66 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.

PLATE No. 9.



Eng 58 1

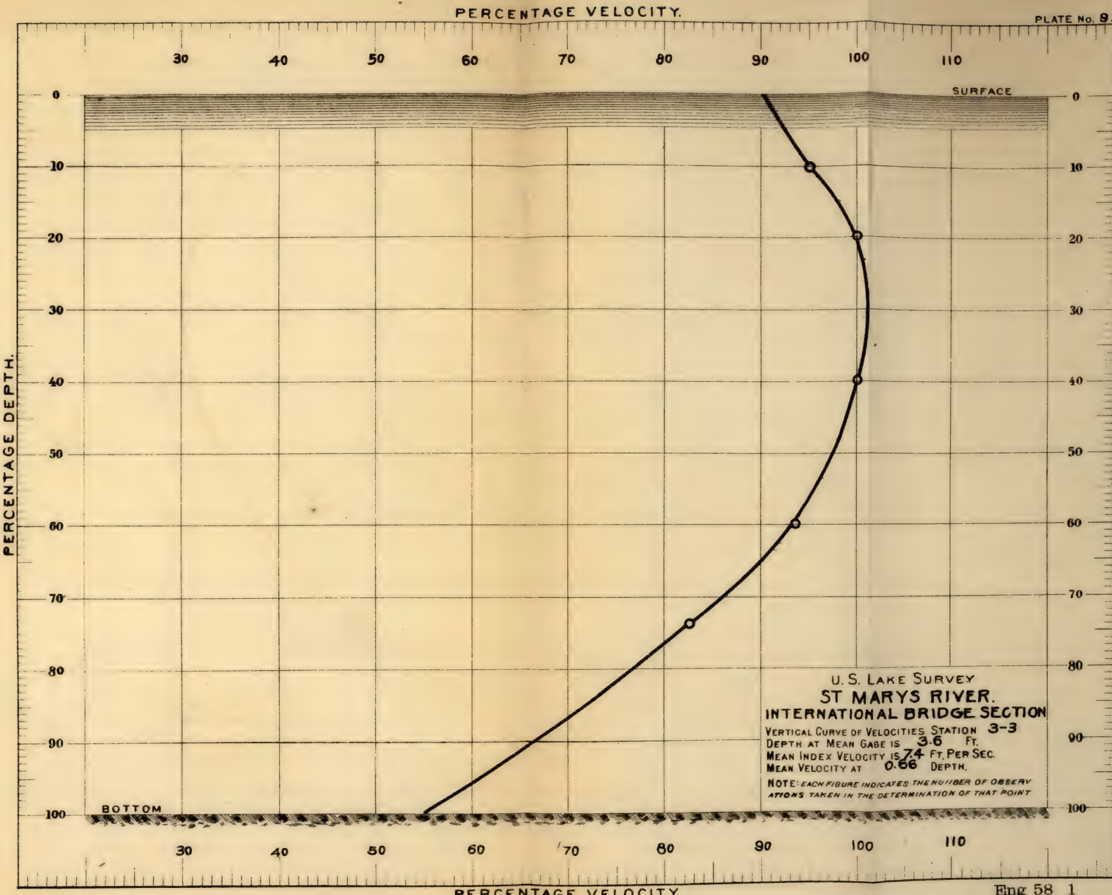
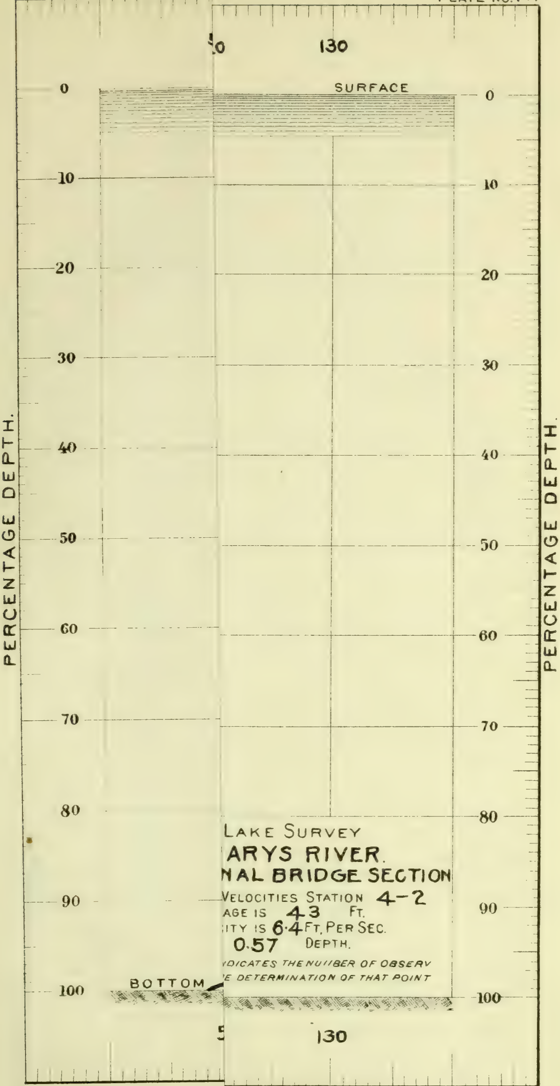
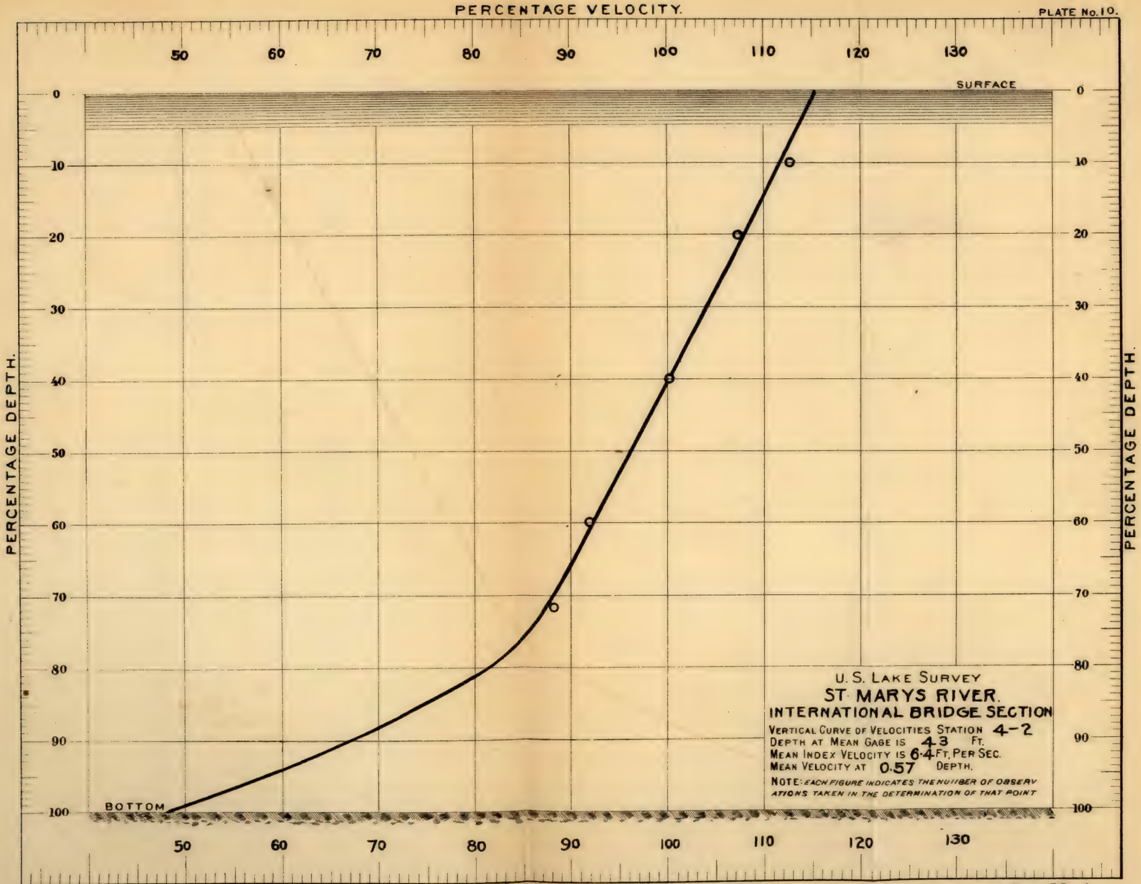

PERCENTAGE VELOCITY.
PLATE No. 9.
30
40
50
60
70
80
90
100
110
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 3-3
DEPTH AT MEAN GAGE IS 3.6 FT.
MEAN INDEX VELOCITY IS 7.4 FT. PER SEC.
MEAN VELOCITY AT 0.66 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT

PLATE No. 10.



THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTO



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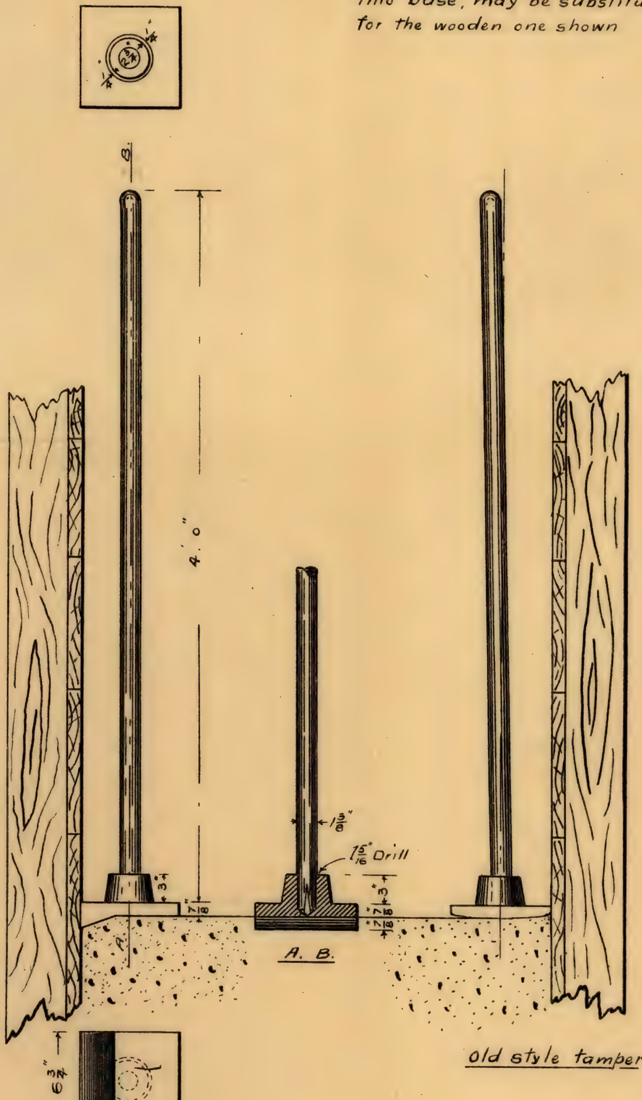
Note —

A handle of gas pipe, tapped into base, may be substituted for the wooden one shown



Cast iron tamper for concrete

Scale $1\frac{1}{2}$" = 1 ft.

Weight of tamper with wooden handle about 18 lbs

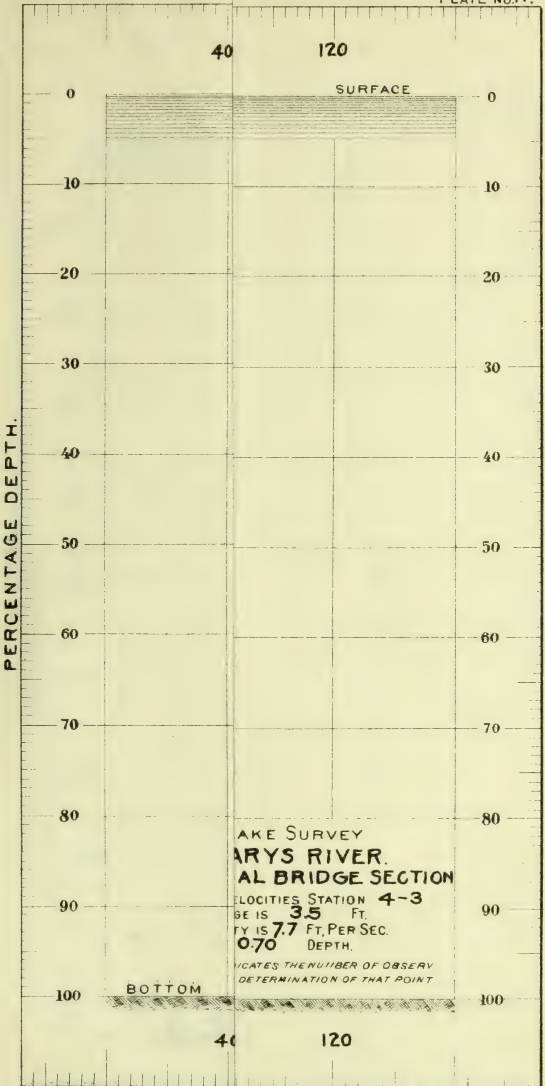
U.S. Engineer Office
Portland Or. Sept 1 1903
To accompany letter of this date to Chief of Engineers U.S.A.

W. C. Langfitt.

Major, Corps of Engineers, U.S.A.

ANDREW B GRAHAM PHOTO-LITHO WASHINGTON D.C.

PLATE No. 11.



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON D

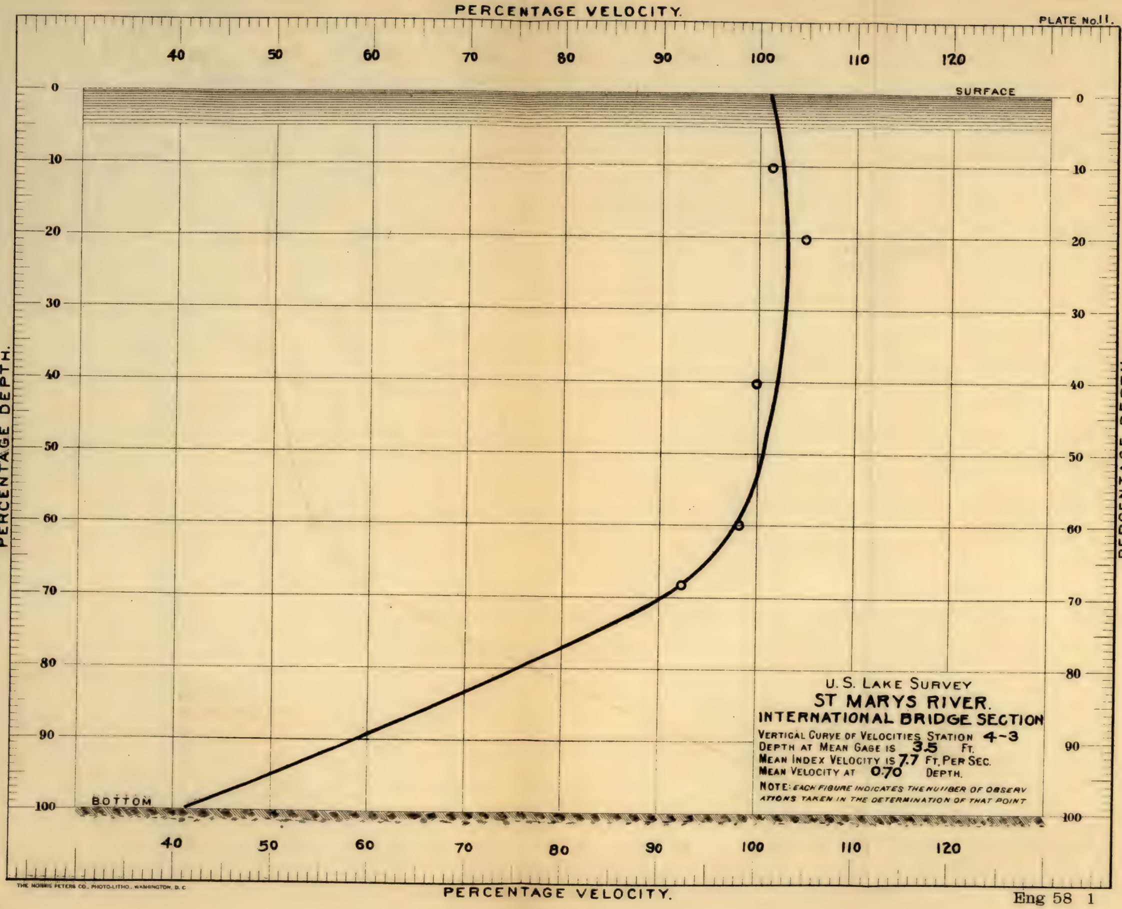
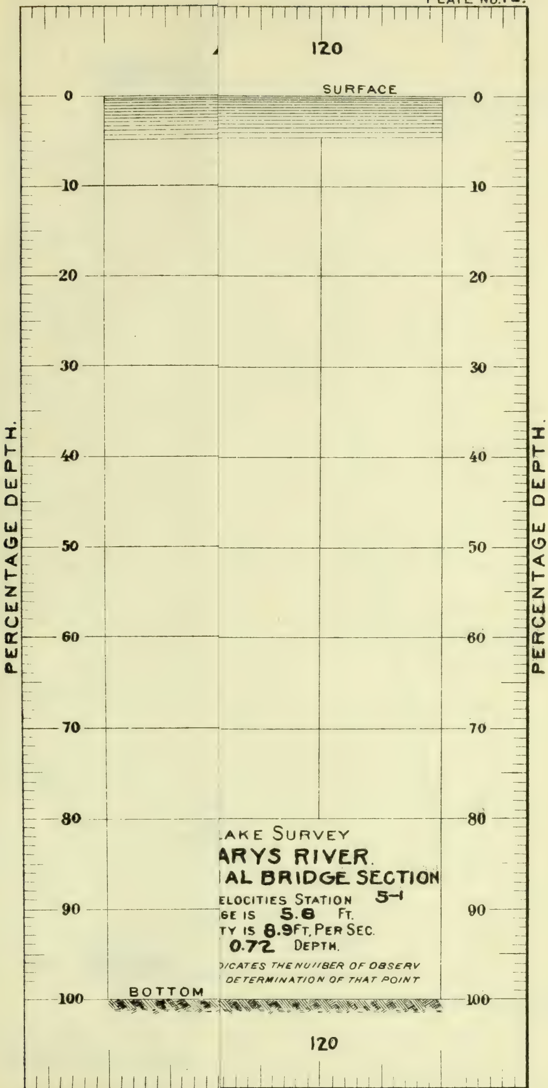
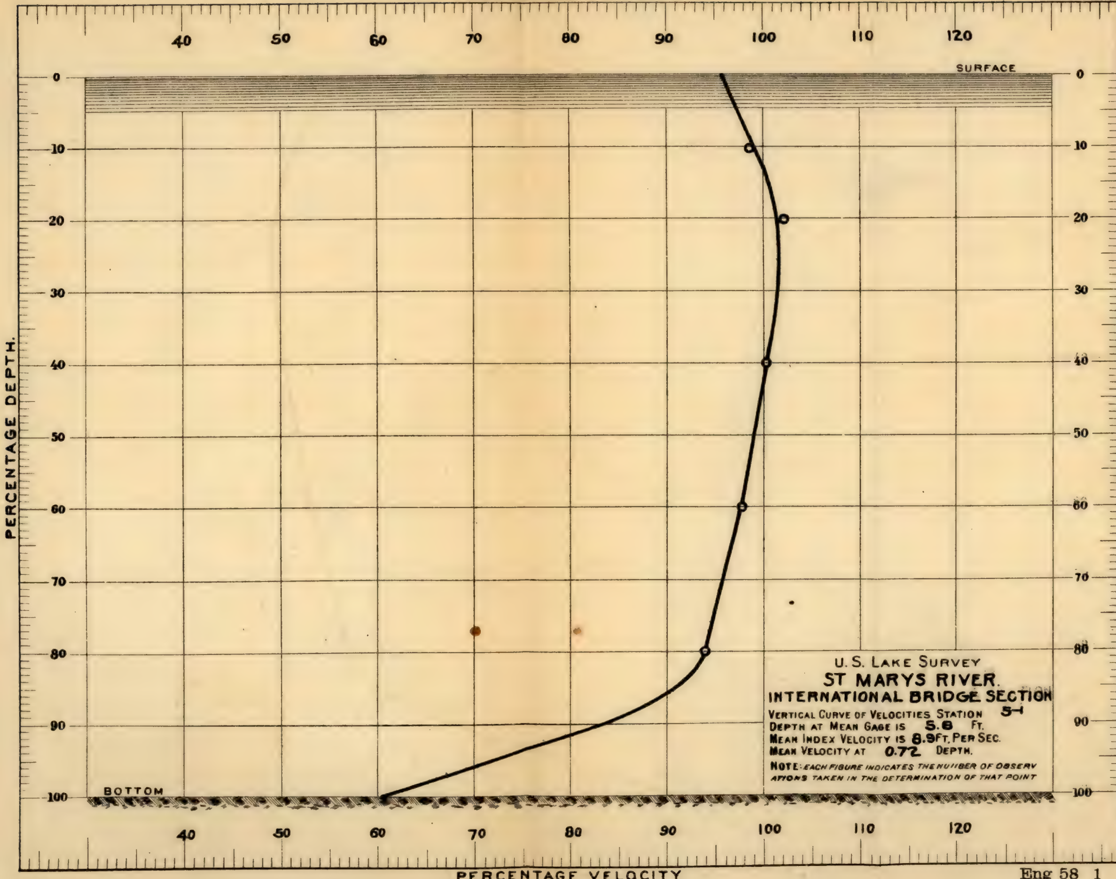

PERCENTAGE VELOCITY.
PLATE No. 11.
PERCENTAGE DEPTH.
SURFACE
BOTTOM
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 4-3
DEPTH AT MEAN GAGE IS 3.5 FT.
MEAN INDEX VELOCITY IS 7.7 FT. PER SEC.
MEAN VELOCITY AT 0.70 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.
THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

PLATE No. 12.



Eng 58 1


PERCENTAGE VELOCITY.
40
50
60
70
80
90
100
110
120
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 5-1
DEPTH AT MEAN GAGE IS 5.8 FT.
MEAN INDEX VELOCITY IS 8.9 FT. PER SEC.
MEAN VELOCITY AT 0.72 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.

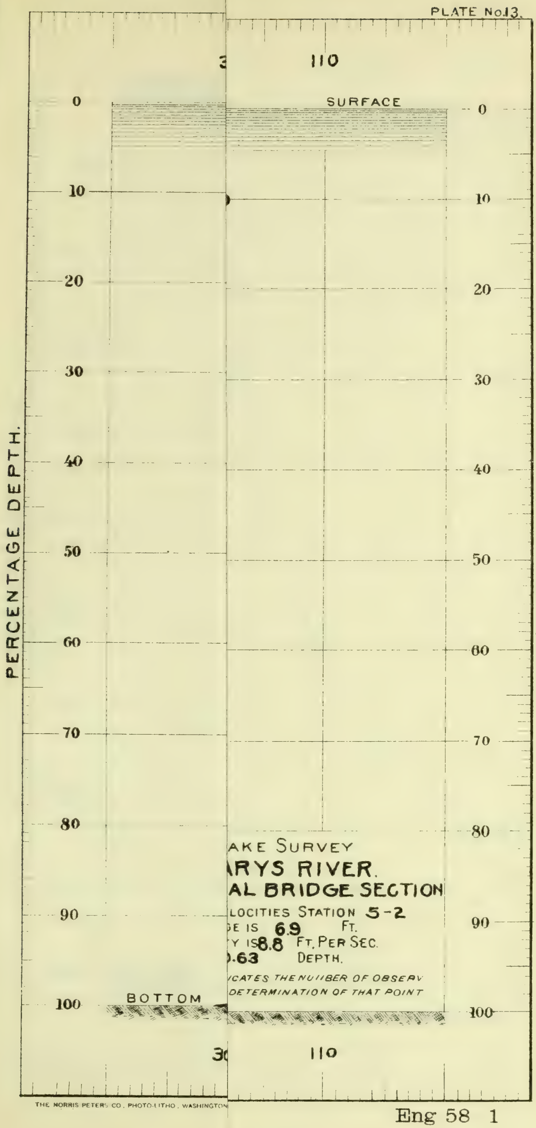


PLATE No.13.
110
SURFACE
PERCENTAGE DEPTH.
AKE SURVEY
ARYS RIVER.
AL BRIDGE SECTION
LOCITIES STATION 5-2
E IS 6.9 FT.
Y IS 8.8 FT. PER SEC.
.63 DEPTH.
CATES THE NUMBER OF OBSERV
DETERMINATION OF THAT POINT
BOTTOM
THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON

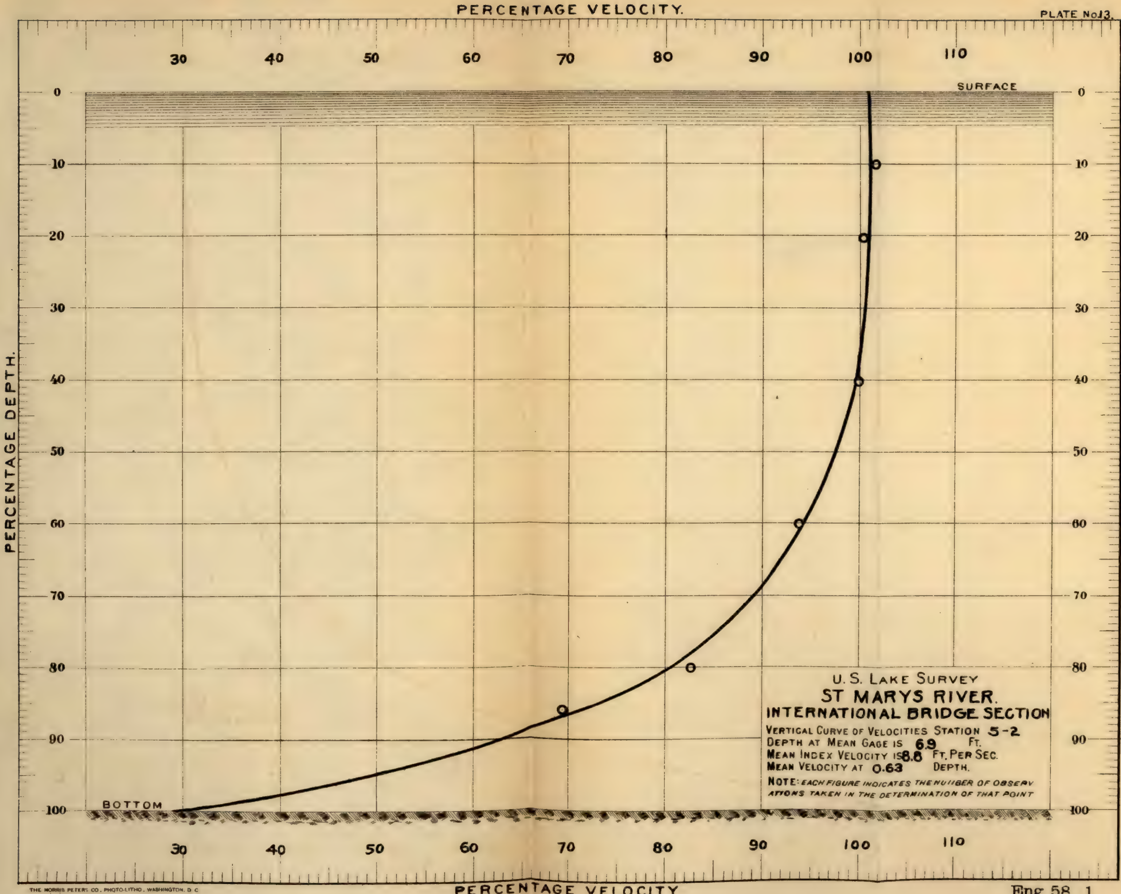
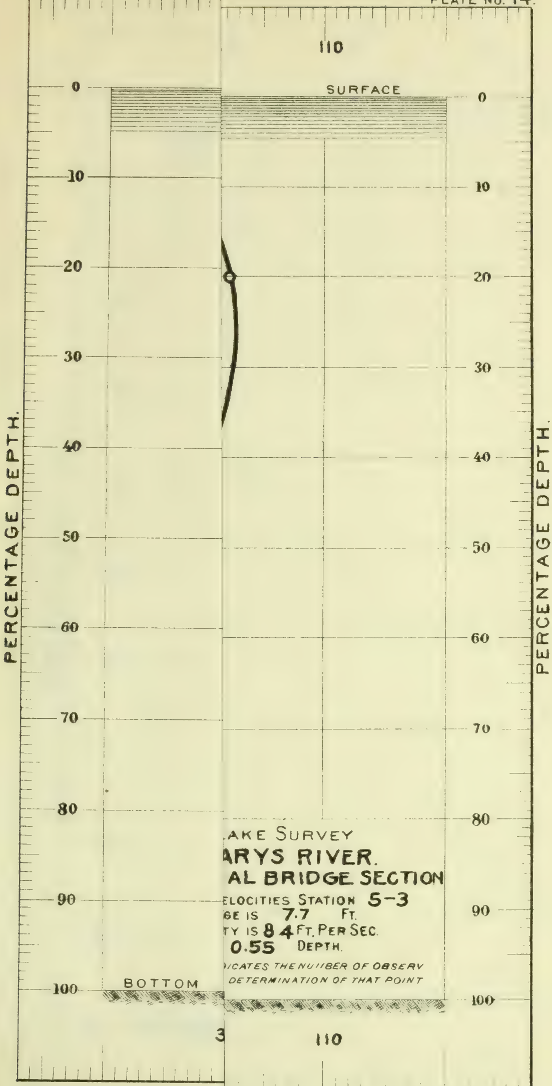
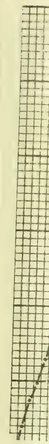
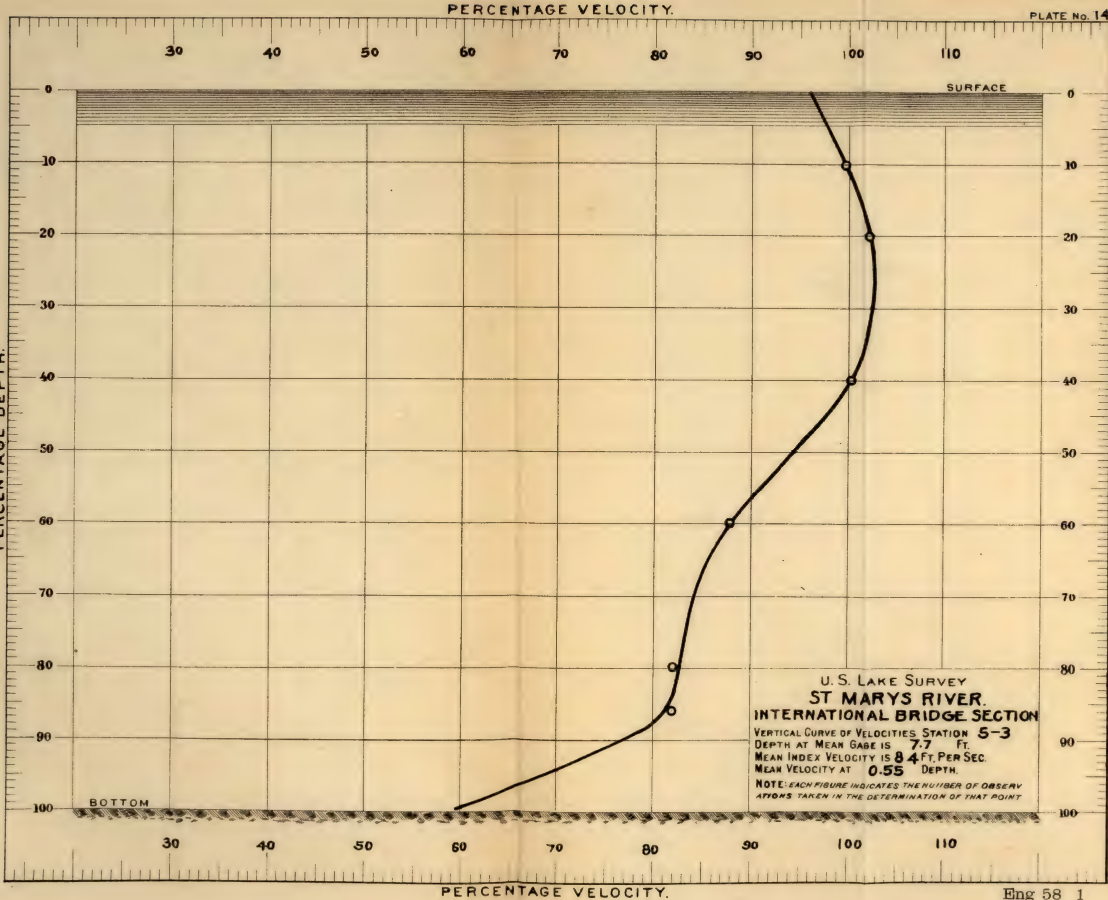

PERCENTAGE VELOCITY.
30
40
50
60
70
80
90
100
110
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 5-2
DEPTH AT MEAN GAGE IS 6.9 FT.
MEAN INDEX VELOCITY IS 8.8 FT. PER SEC.
MEAN VELOCITY AT 0.63 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.

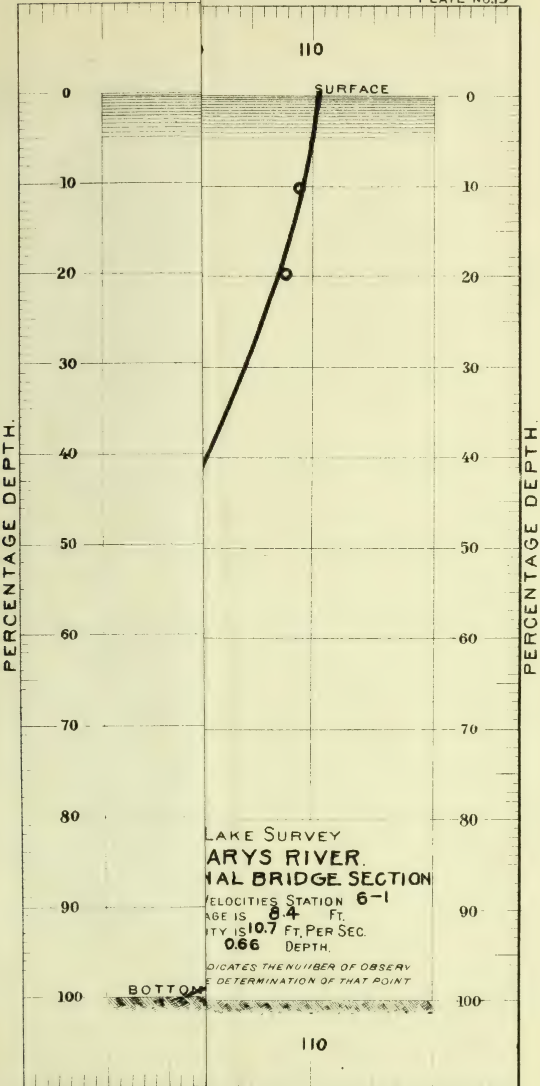
PLATE No. 14.





Eng 58 1


PERCENTAGE VELOCITY.
30
40
50
60
70
80
90
100
110
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 5-3
DEPTH AT MEAN GAGE IS 7.7 FT.
MEAN INDEX VELOCITY IS 8.4 FT. PER SEC.
MEAN VELOCITY AT 0.55 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.



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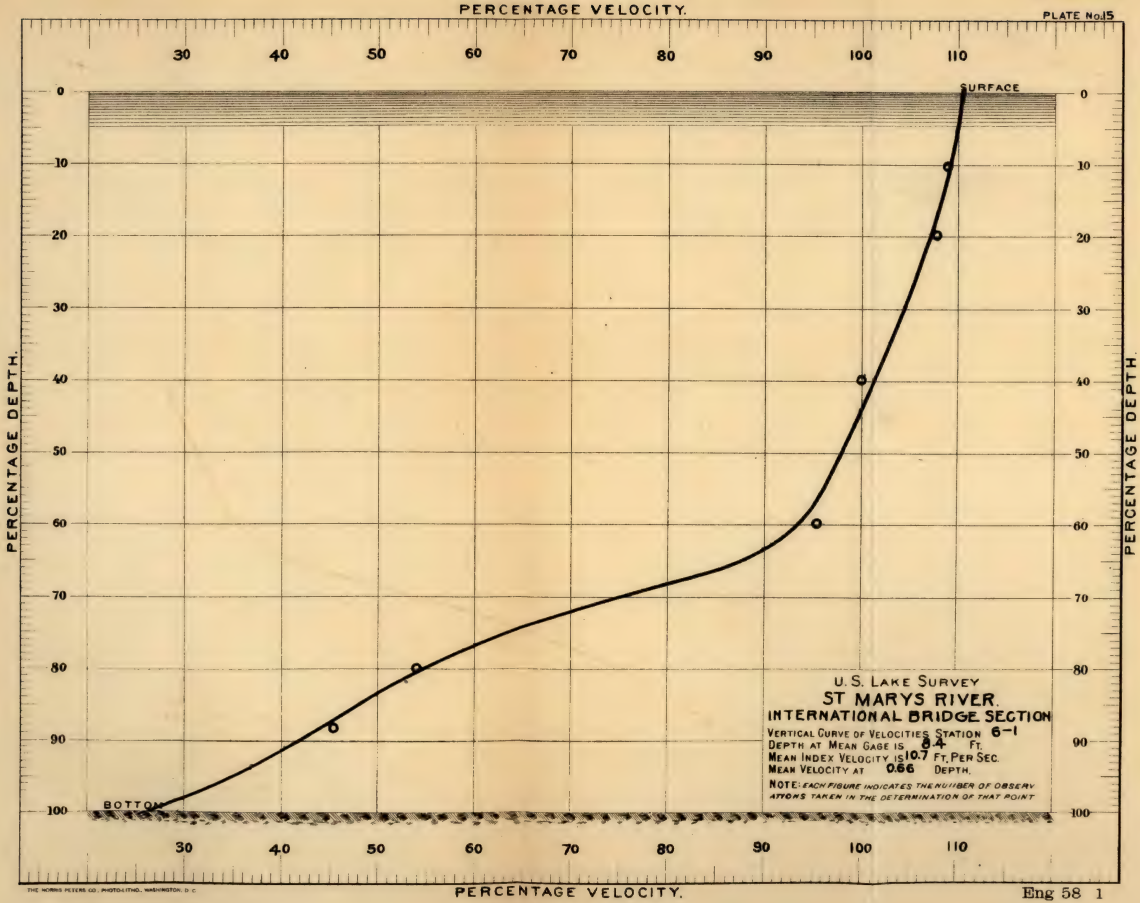

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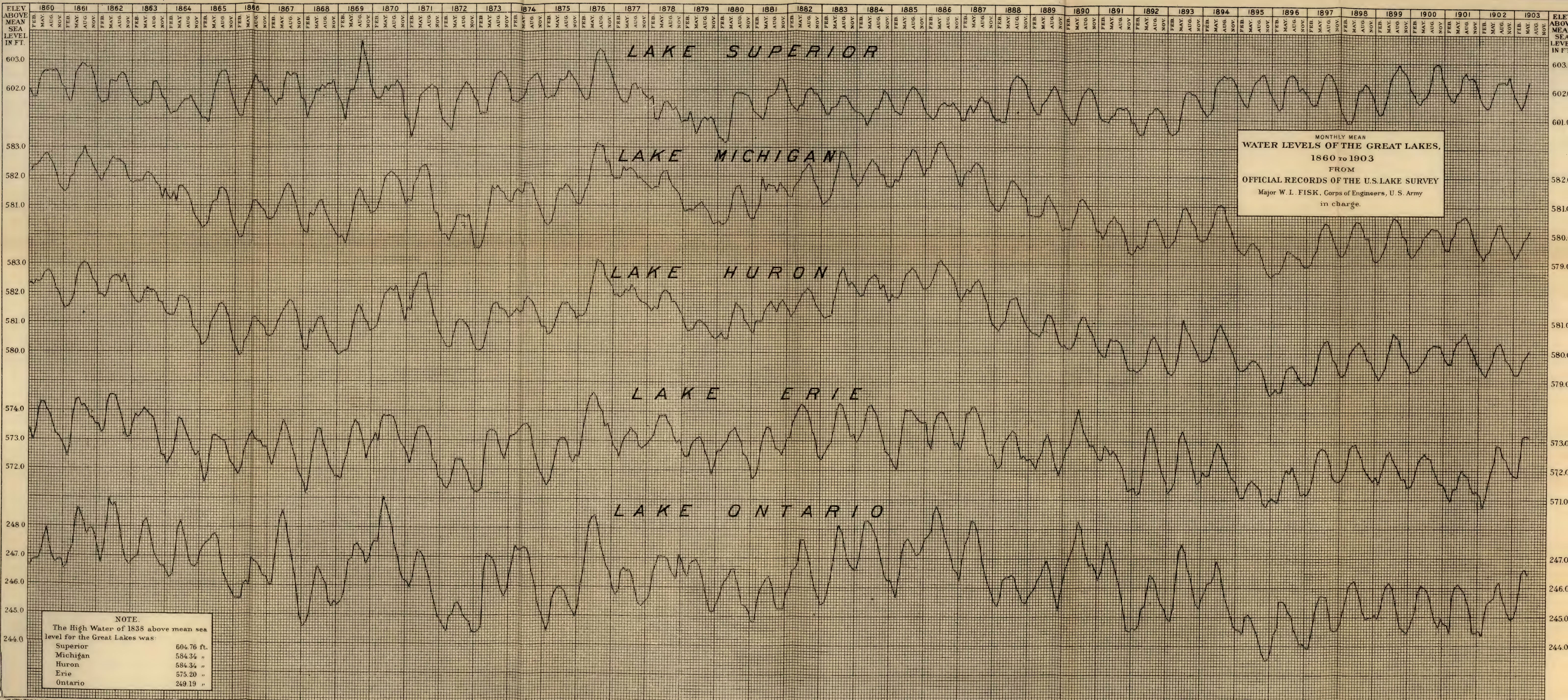

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PLATE No. 2.

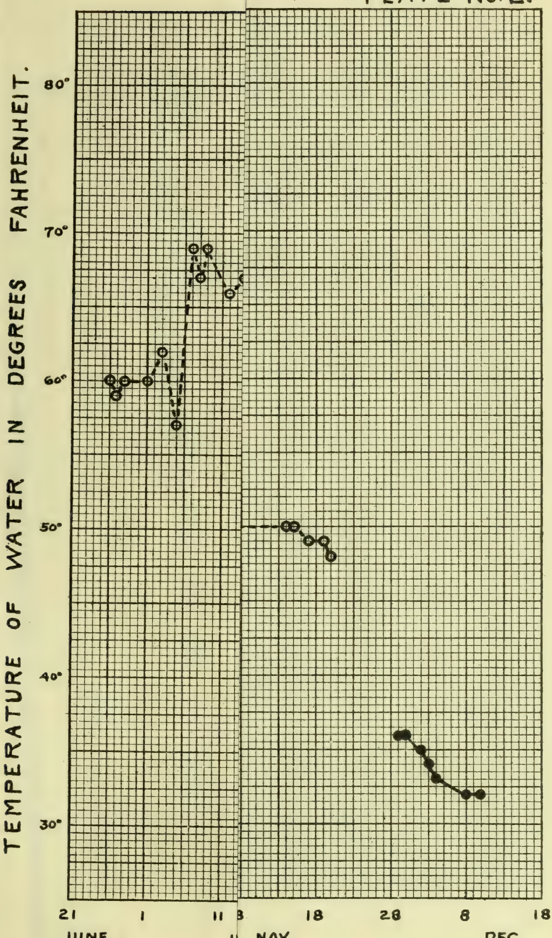
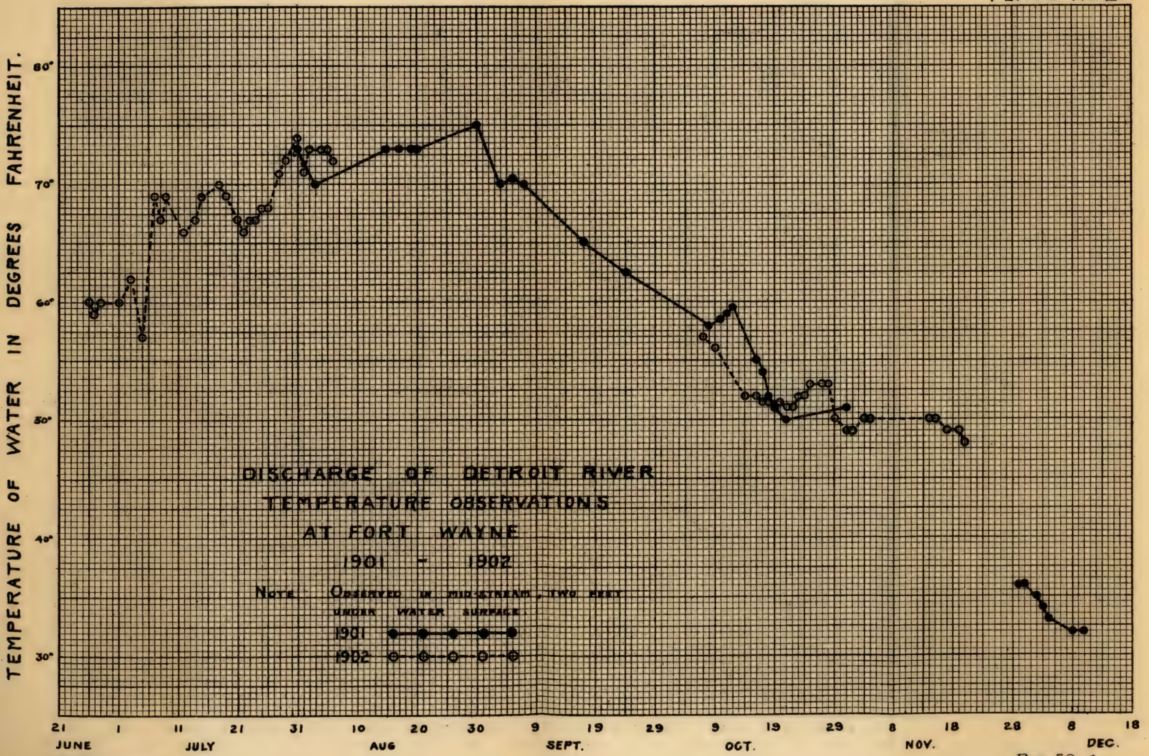

TEMPERATURE OF WATER IN DEGREES FAHRENHEIT.
80°
70°
60°
50°
40°
30°
21
1
11
3
18
28
8
18
JUNE
JU
NOV.
DEC.

PLATE No. 2.



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Eng 58 1


47°05'
2
46°55'
46°45'
46°35'

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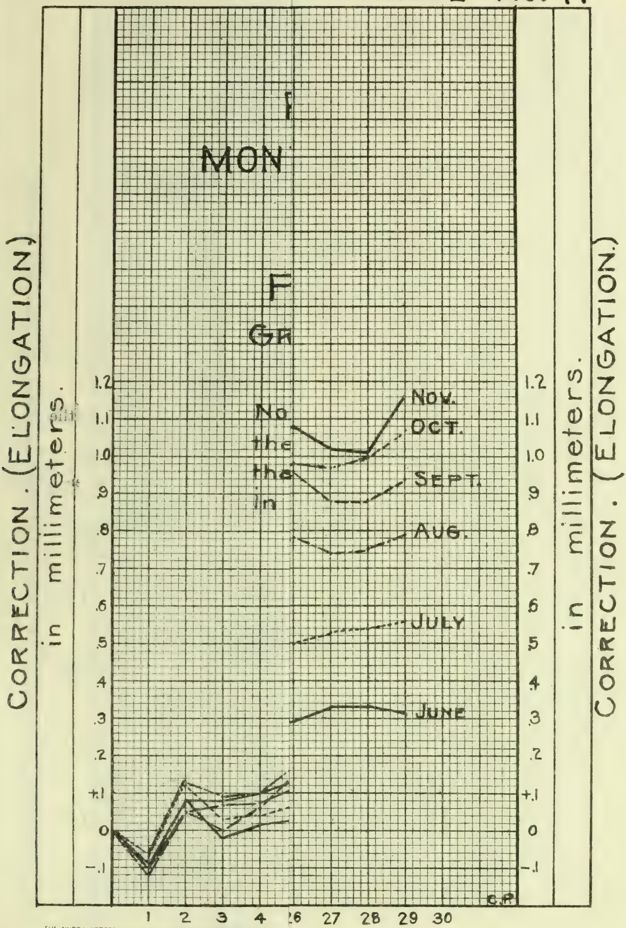
PLATE No. 1.



THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D. C.

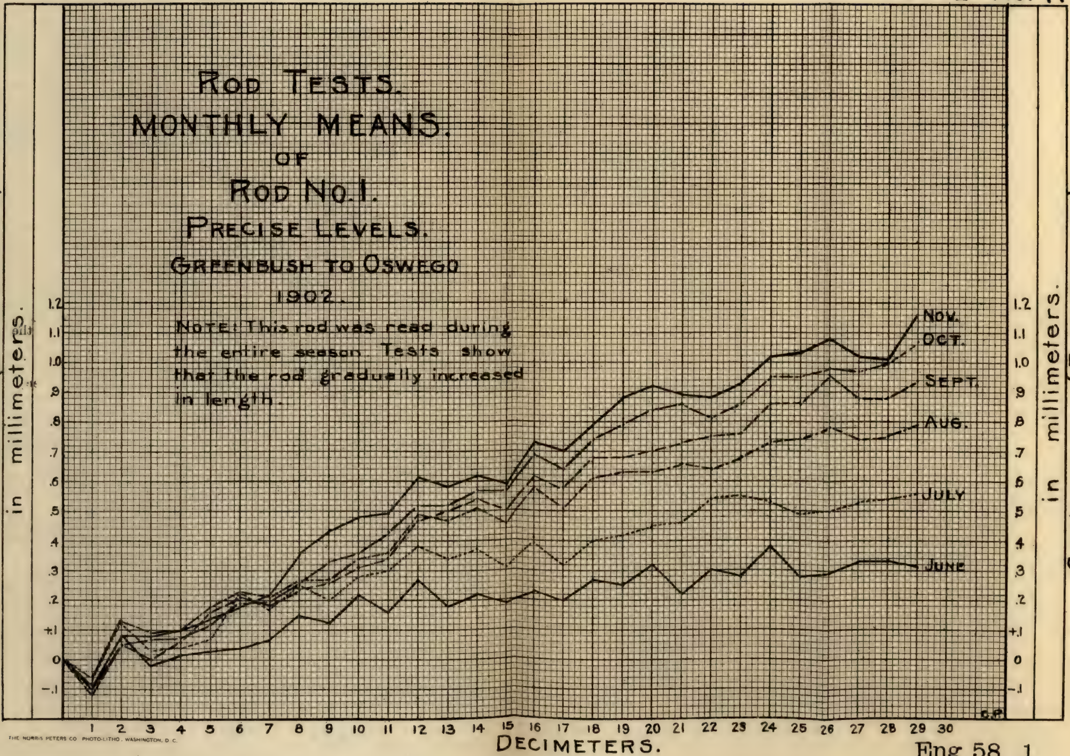


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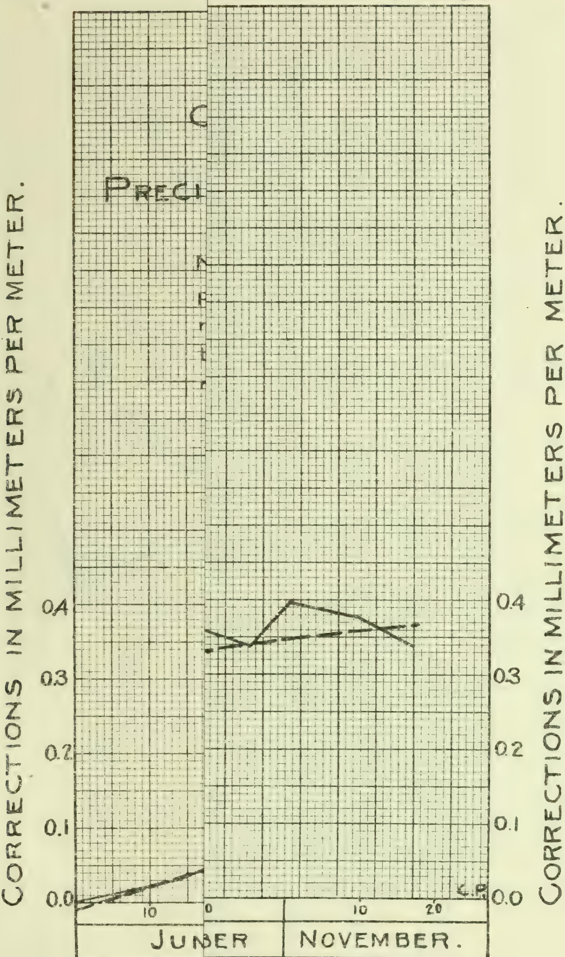
PLATE No. 2.



Eng 58 1

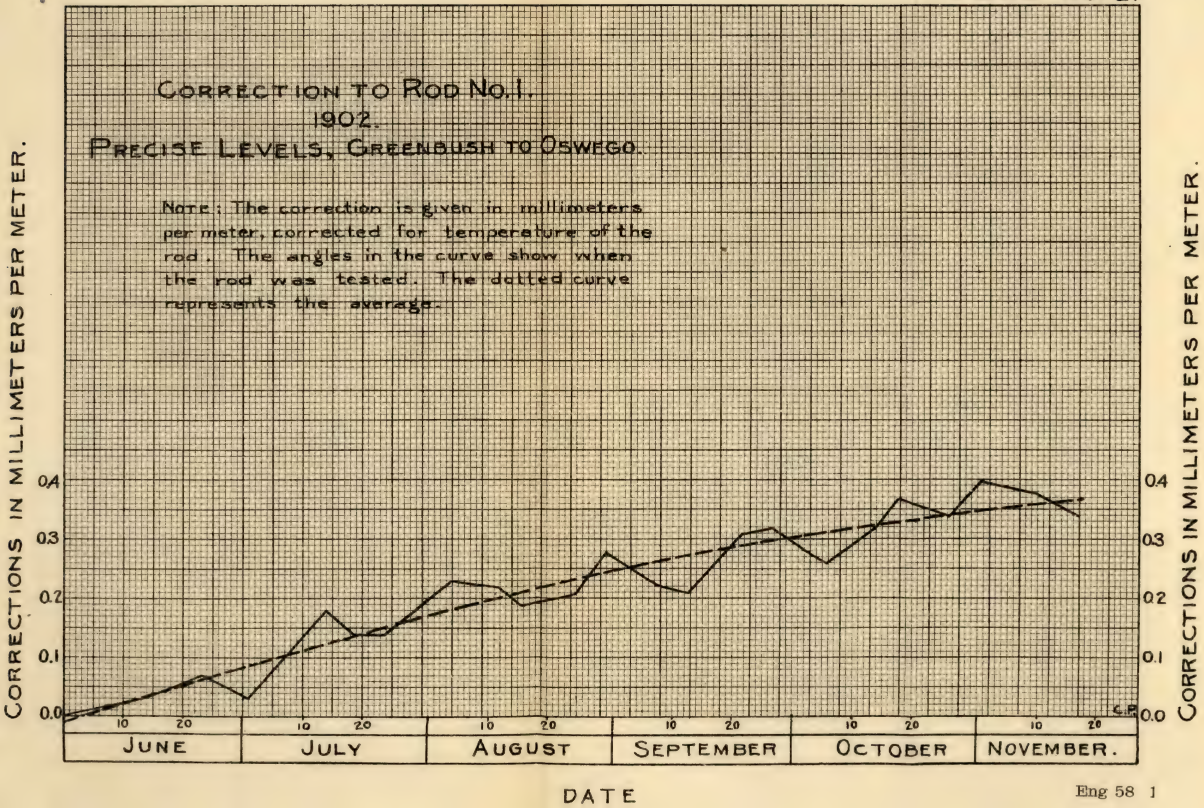
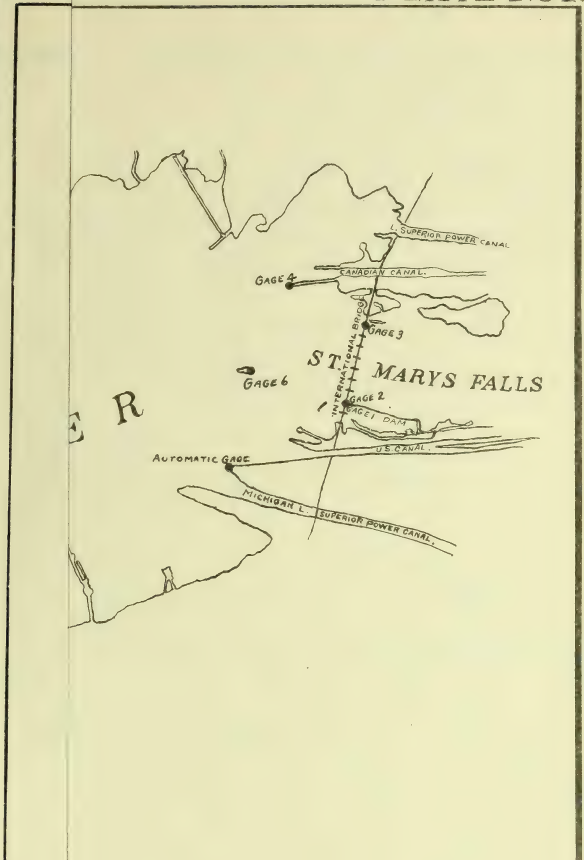

CORRECTION TO ROD No. 1.
1902.
PRECISE LEVELS, GREENBUSH TO OSWEGO.
NOTE: The correction is given in millimeters per meter, corrected for temperature of the rod. The angles in the curve show when the rod was tested. The dotted curve represents the average.
CORRECTIONS IN MILLIMETERS PER METER.
0.4
0.3
0.2
0.1
0.0
10
20
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER.
DATE
C.P.

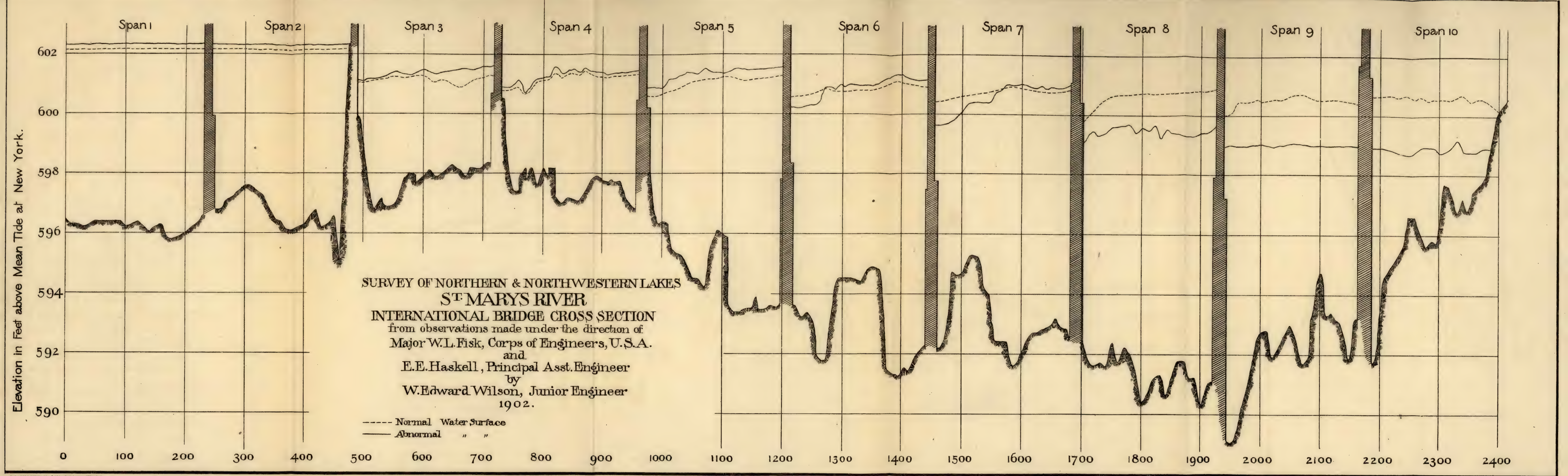
PLATE No 1.


L. SUPERIOR POWER CANAL
CANADIAN CANAL.
GAGE 4
INTERNATIONAL BRIDGE
GAGE 3
ST. MARYS FALLS
GAGE 6
E R
GAGE 2
GAGE 1 DAM
AUTOMATIC GAGE
U.S. CANAL.
MICHIGAN L. SUPERIOR POWER CANAL.

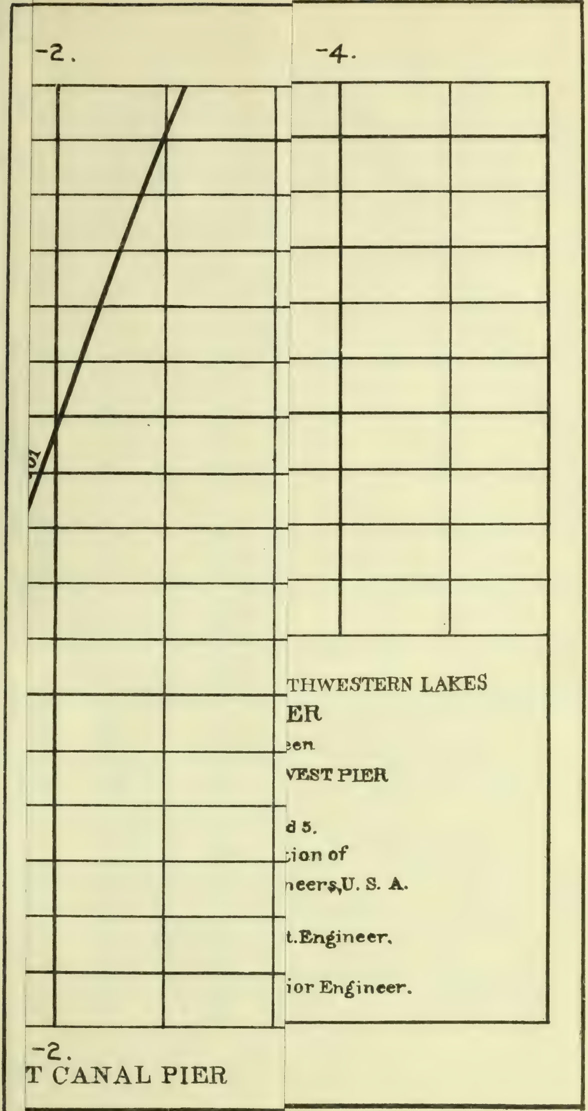

SURVEY OF NORTHERN AND NORTHWESTERN LAKES
Map of
ST. MARYS RIVER
showing location of
BRIDGE SECTION AND GAGES
made under the direction of
Maj. W. L. FISK, Corps of Engineers U.S.A.
and
E. E. HASKELL, Chief Asst. Engineer
by
W. EDWARD WILSON, Jun. Engineer.
1902.
SCALE
1/40000
POINT AUX PINS BAY
ST. MARYS RIVER
ST. MARYS FALLS
L. SUPERIOR POWER CANAL
CANADIAN CANAL.
GAGE 4
INTERNATIONAL BRIDGE
GAGE 3
GAGE 6
GAGE 2
GAGE 1
DAM
U.S. CANAL.
AUTOMATIC GAGE
MICHIGAN L. SUPERIOR POWER CANAL.
GAGE 5
GAGE 8

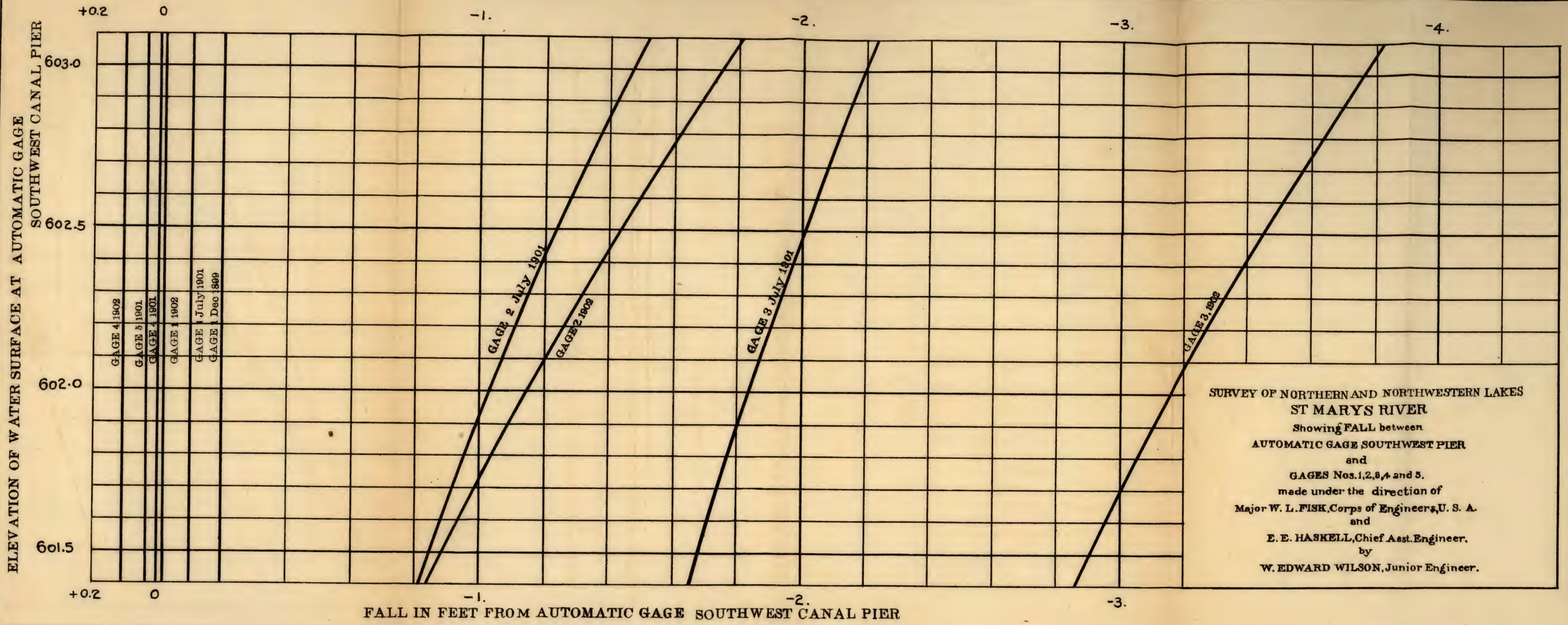

900

PLATE No. 2.



Eng 58 1


-2.
-4.
THWESTERN LAKES
ER
een
VEST PIER
d 5.
tion of
neers, U. S. A.
t. Engineer.
ior Engineer.
-2.
T CANAL PIER



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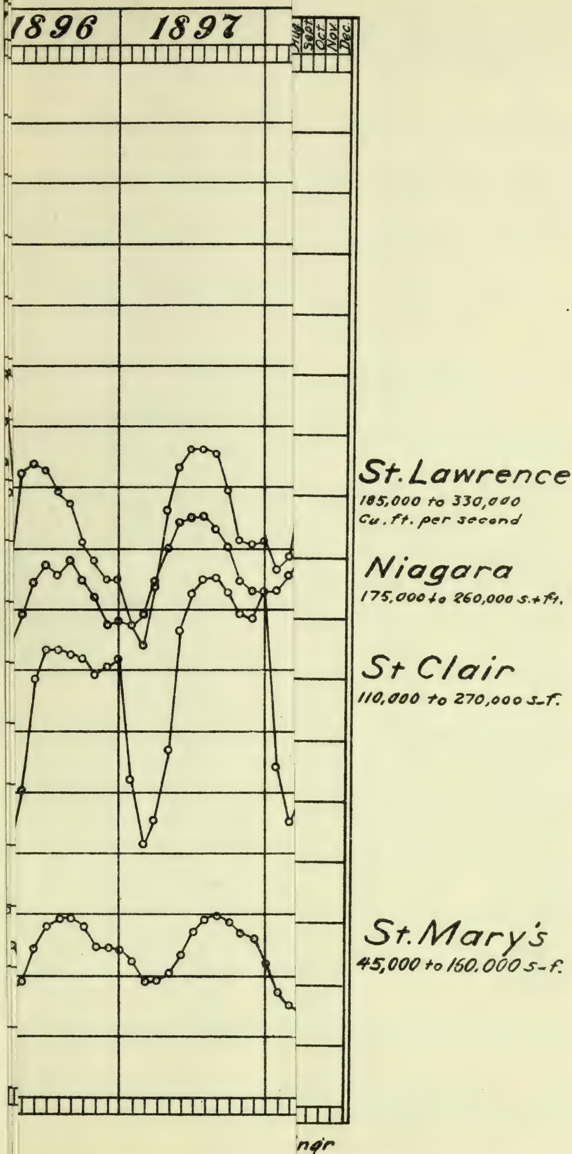
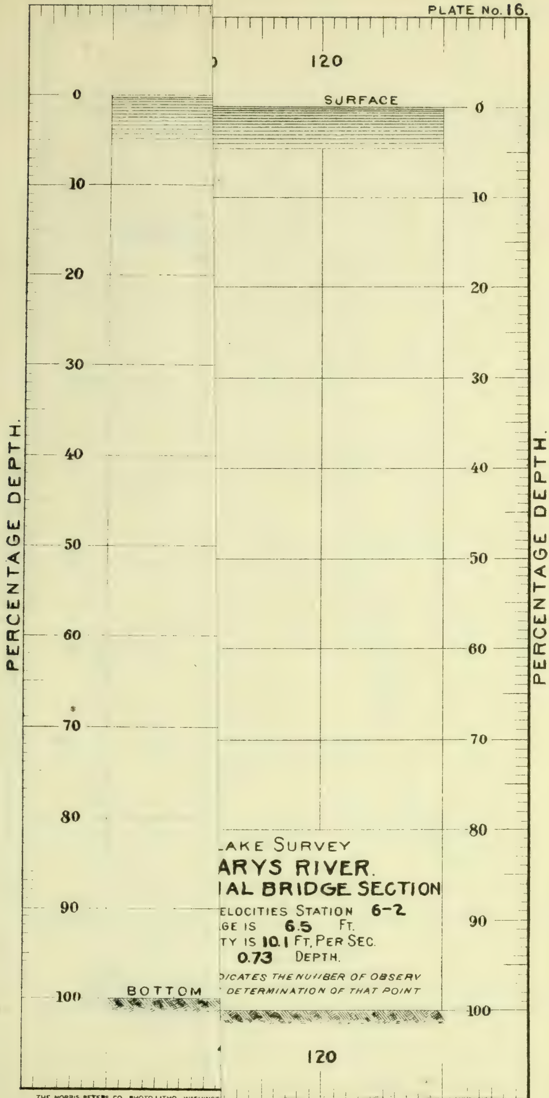

1896
1897
Aug.
Sept.
Oct.
Nov.
Dec.
St. Lawrence
185,000 to 330,000
Cu. ft. per second
Niagara
175,000 to 260,000 s.+ft.
St Clair
110,000 to 270,000 s-f.
St. Mary's
45,000 to 160.000 s-f.
ngr


PLATE 2.
Curves
Showing graphically the discharge in s-f
through
St. Marys, St. Clair, Niagara and
St. Lawrence Rivers.
from 1860 to 1902.
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
s-f.
350,000
330 "
310 "
290 "
270 "
250 "
230 "
210 "
190 "
170 "
150 "
130 "
110 "
90 "
70 "
50 "
30 "
Niagara
St. Clair
St. Lawrence
St. Marys
St. Lawrence
185,000 to 330,000
Cu. ft. per second
Niagara
175,000 to 260,000 s.-f.
St Clair
110,000 to 270,000 s.-f.
St. Mary's
45,000 to 160,000 s.-f.
H.R. Allen Jun Engr
Del.

Eng 58 1



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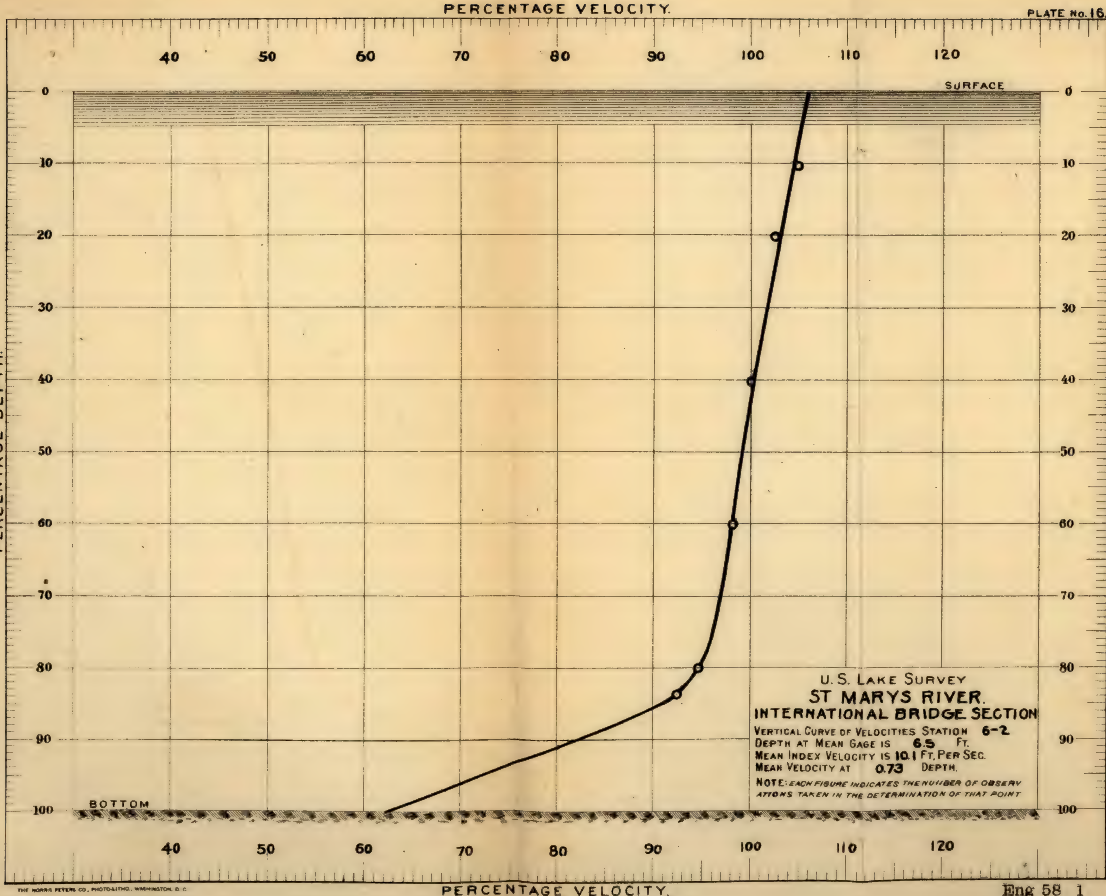
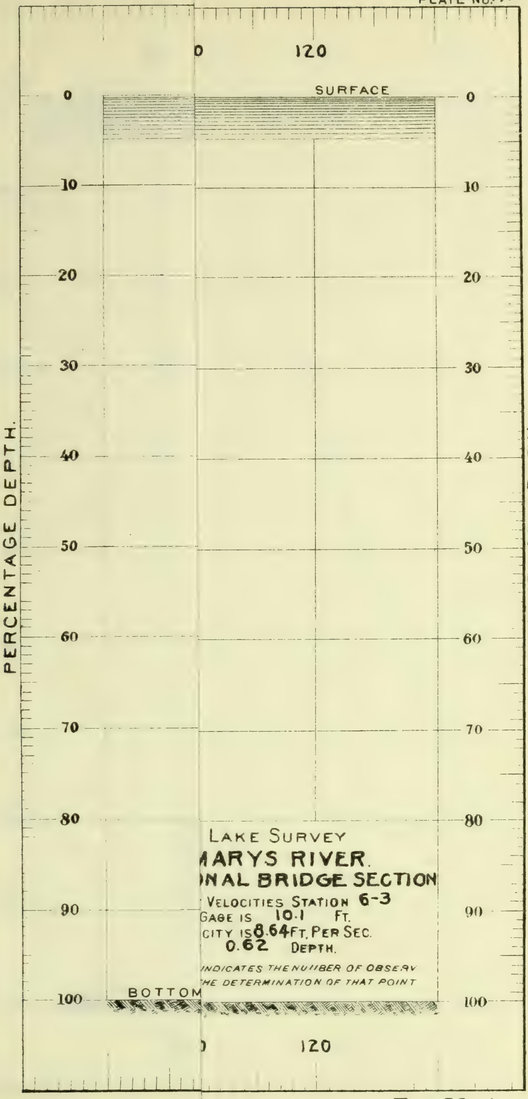


THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.


0
120
SURFACE
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
LAKE SURVEY
MARYS RIVER.
NAL BRIDGE SECTION
VELOCITIES STATION 6-3
GAGE IS 10.1 FT.
CITY IS 8.64 FT. PER SEC.
0.62 DEPTH.
INDICATES THE NUMBER OF OBSERV
THE DETERMINATION OF THAT POINT
BOTTOM
120

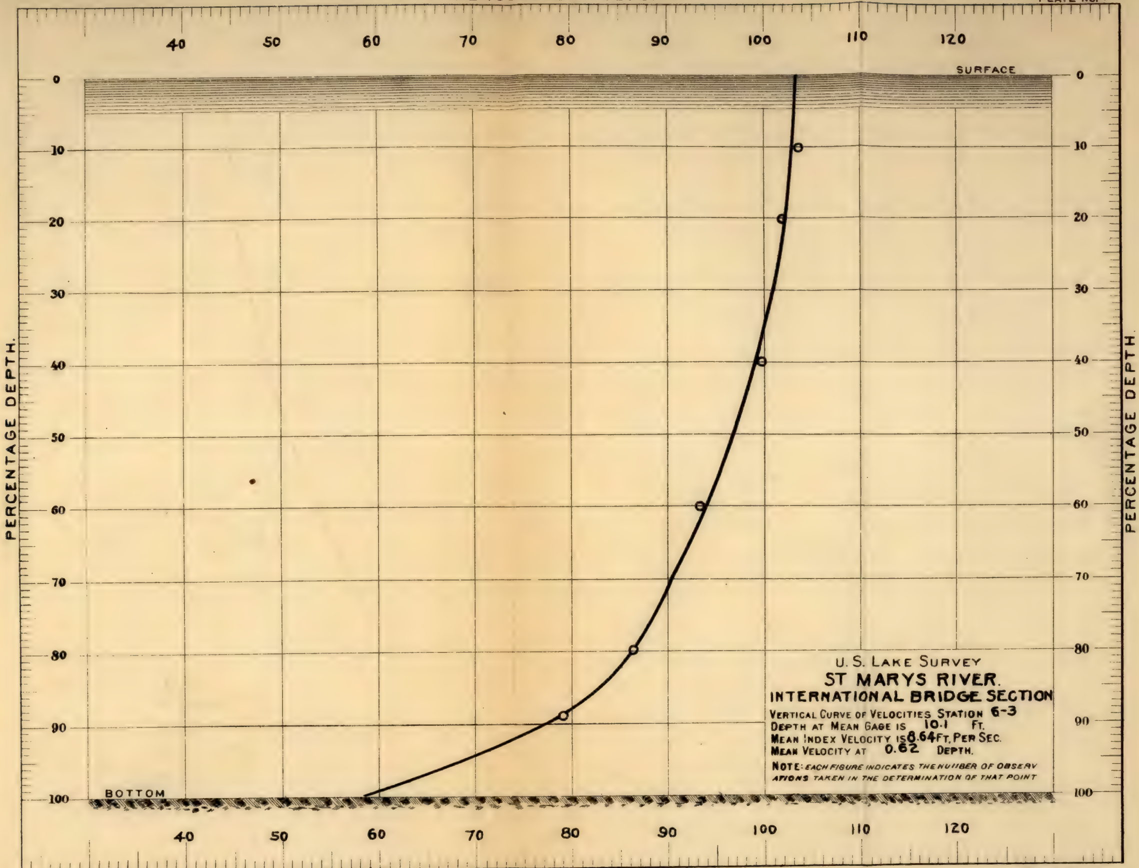
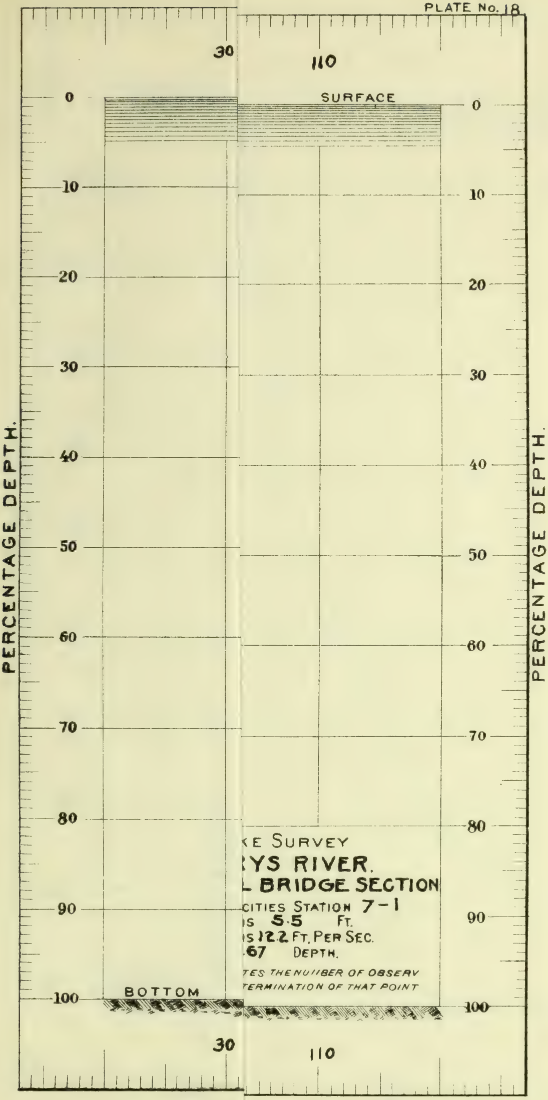

PERCENTAGE VELOCITY.
PERCENTAGE DEPTH.
SURFACE
BOTTOM
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 6-3
DEPTH AT MEAN GAGE IS 10.1 FT.
MEAN INDEX VELOCITY IS 8.64 FT. PER SEC.
MEAN VELOCITY AT 0.62 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.

PLATE No. 18.



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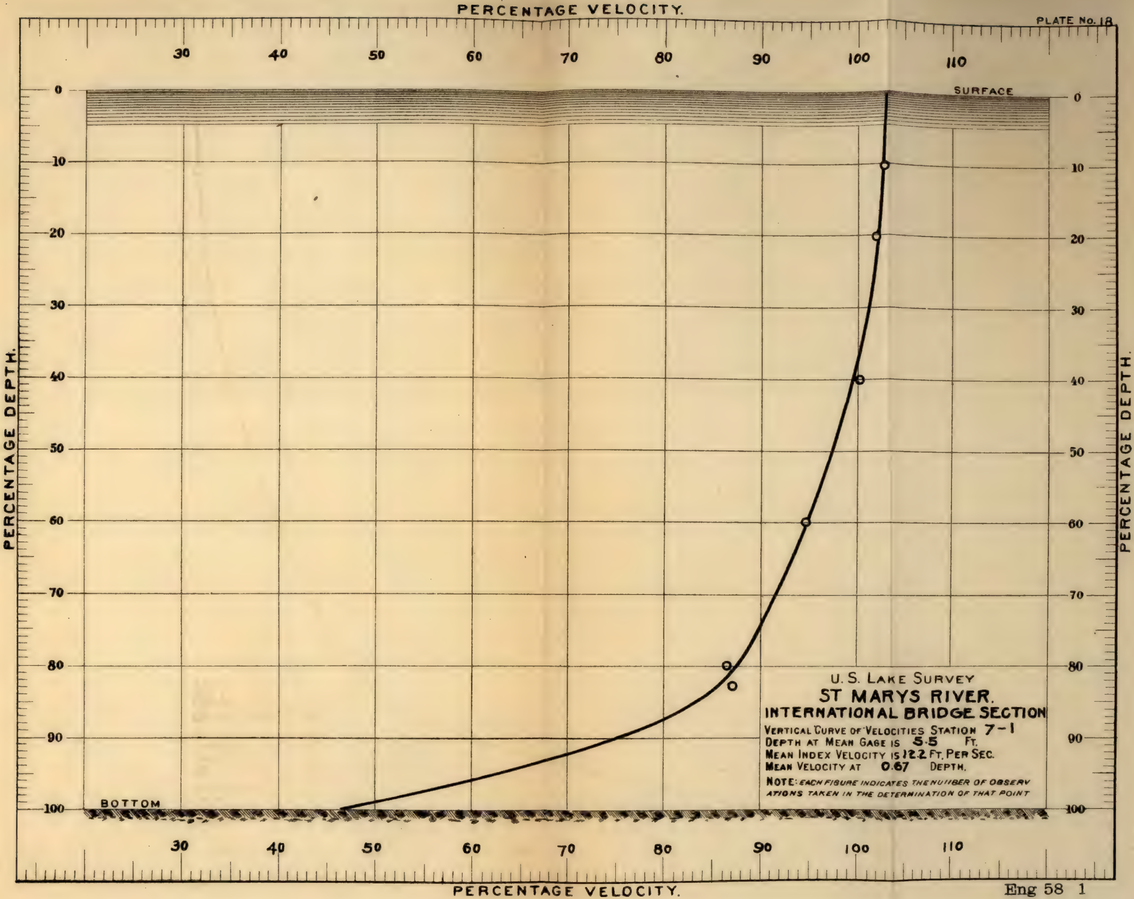
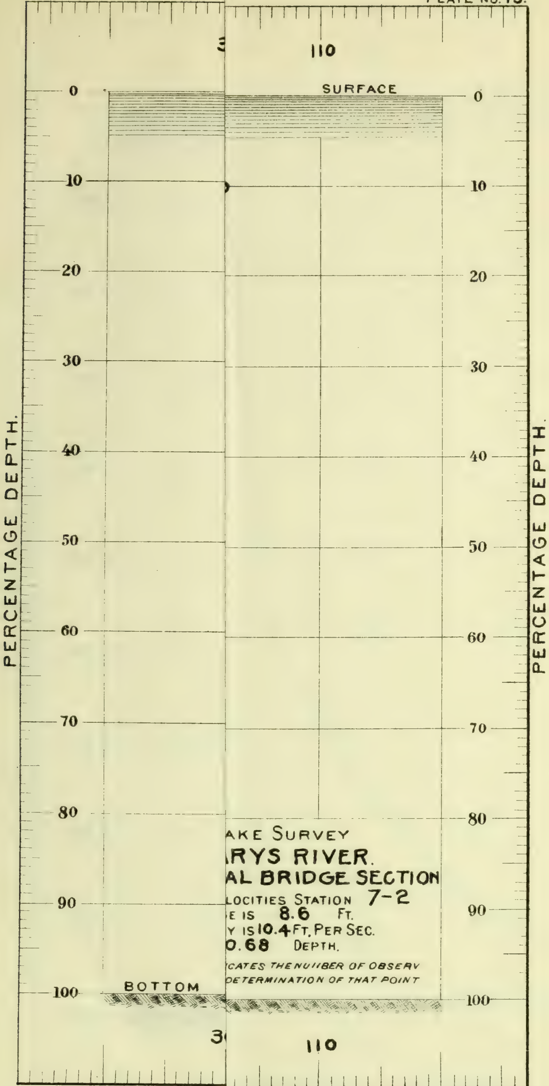


PLATE No. 18
PERCENTAGE VELOCITY.
PERCENTAGE DEPTH.
SURFACE
BOTTOM
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 7-1
DEPTH AT MEAN GAGE IS 5.5 FT.
MEAN INDEX VELOCITY IS 12.2 FT. PER SEC.
MEAN VELOCITY AT 0.67 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT

PLATE No. 19.



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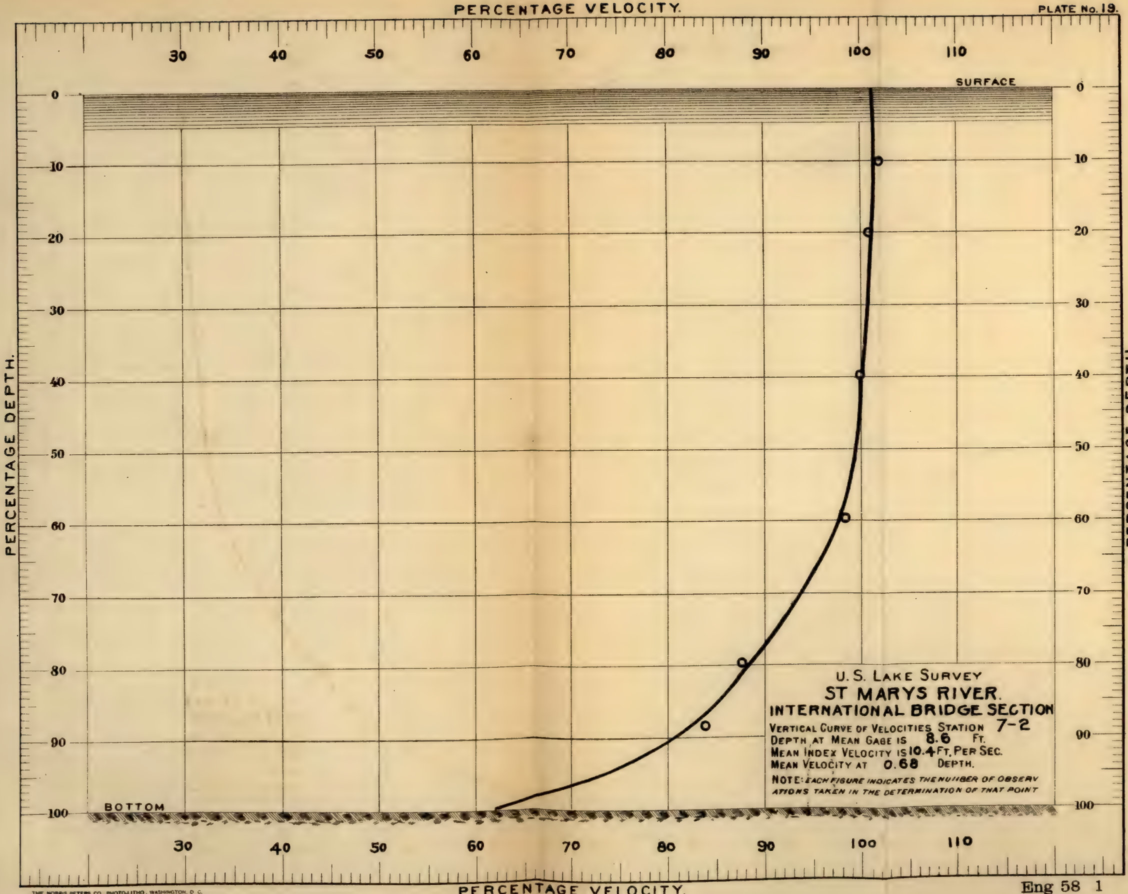
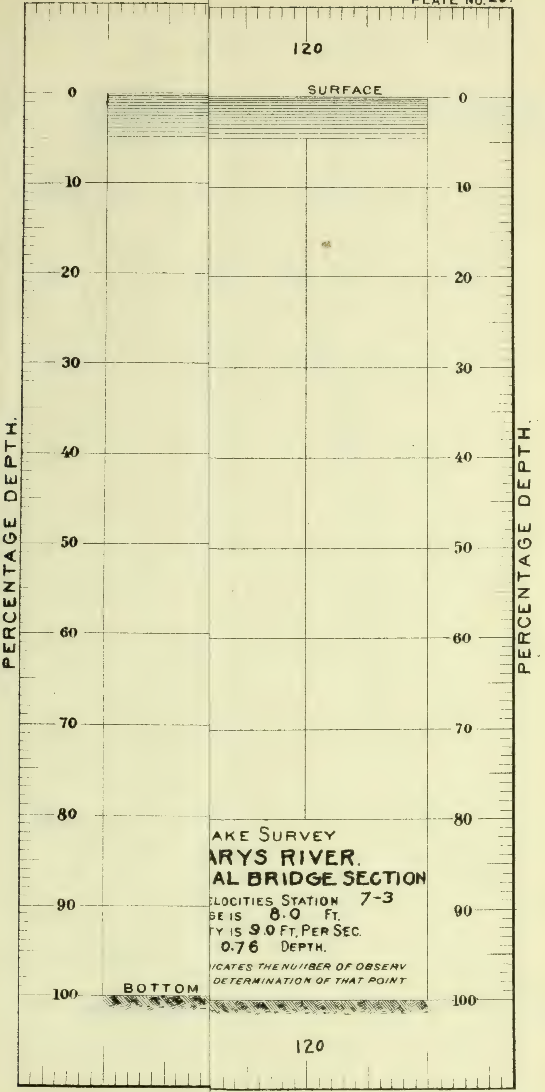


THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

PLATE No. 20.



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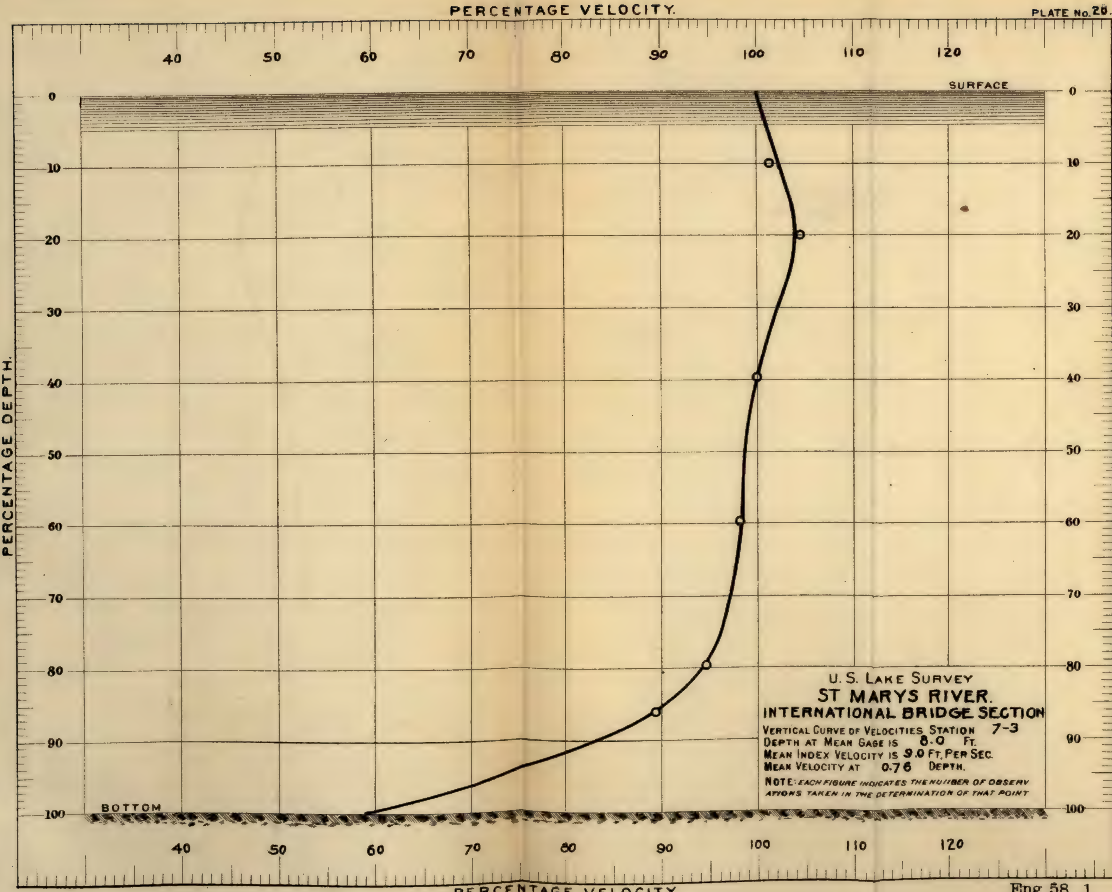
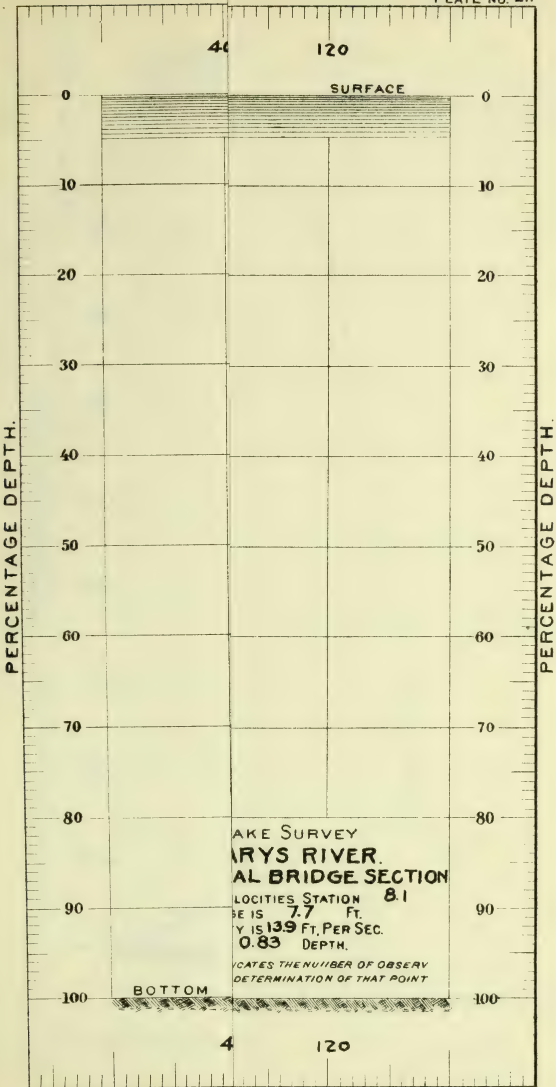

PERCENTAGE VELOCITY.
40 50 60 70 80 90 100 110 120
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0 10 20 30 40 50 60 70 80 90 100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 7-3
DEPTH AT MEAN GAGE IS 8.0 FT.
MEAN INDEX VELOCITY IS 9.0 FT. PER SEC.
MEAN VELOCITY AT 0.76 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT

PLATE No. 21.



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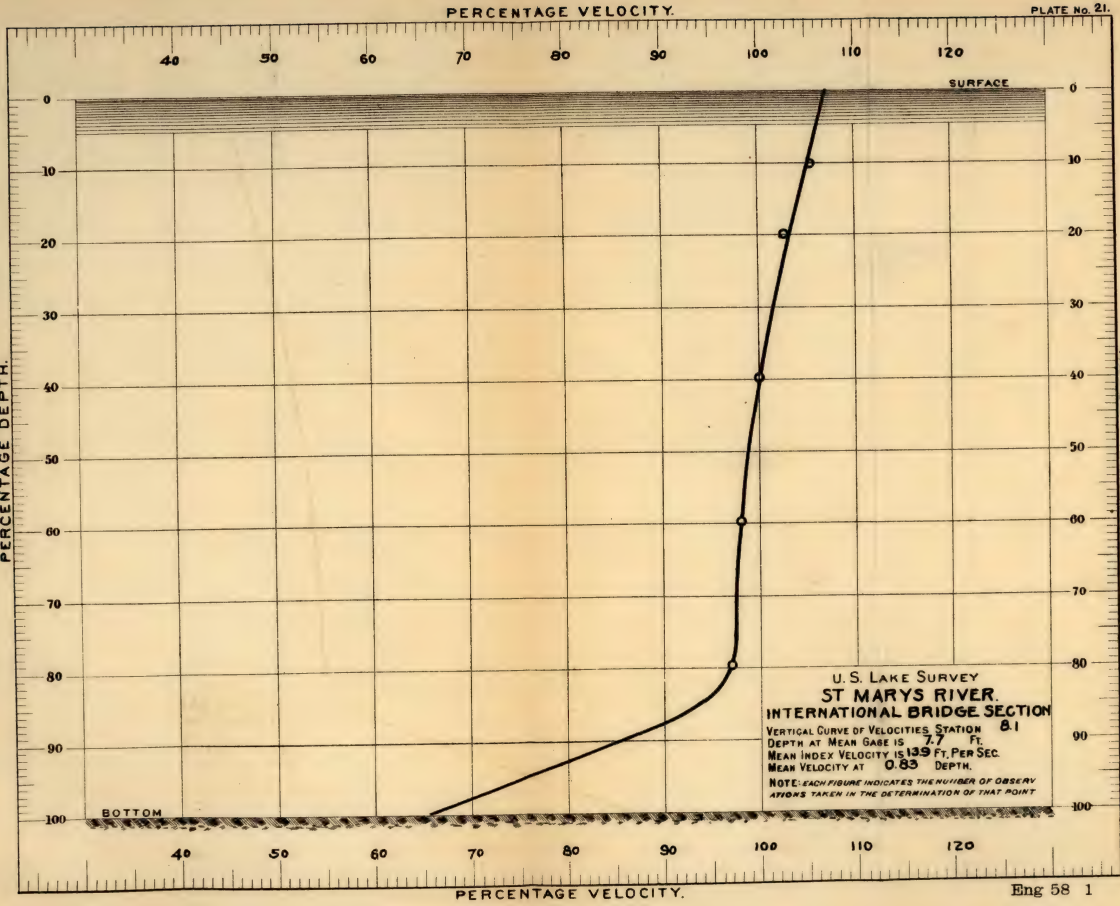
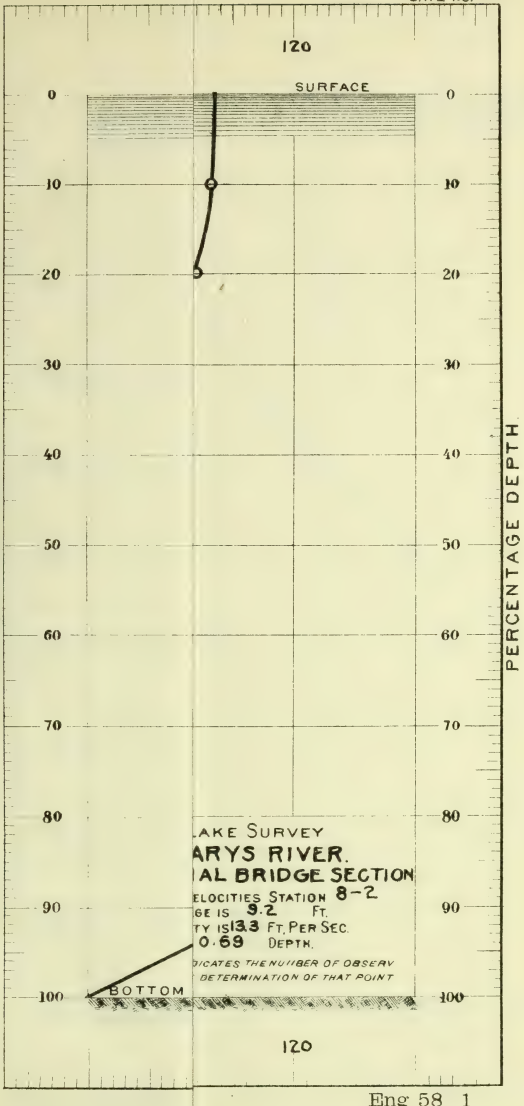

PERCENTAGE VELOCITY.
40
50
60
70
80
90
100
110
120
SURFACE
BOTTOM
PERCENTAGE DEPTH.
0
10
20
30
40
50
60
70
80
90
100
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 8.1
DEPTH AT MEAN GAGE IS 7.7 FT.
MEAN INDEX VELOCITY IS 13.9 FT. PER SEC.
MEAN VELOCITY AT 0.83 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT


120
SURFACE
0
10
20
30
40
50
60
70
80
90
100
PERCENTAGE DEPTH.
PERCENTAGE DEPTH.
LAKE SURVEY
ARYS RIVER.
IAL BRIDGE SECTION
ELOCITIES STATION 8-2
GE IS 9.2 FT.
TY IS 13.3 FT. PER SEC.
0.69 DEPTH.
DICATES THE NUMBER OF OBSERV
DETERMINATION OF THAT POINT
BOTTOM
120

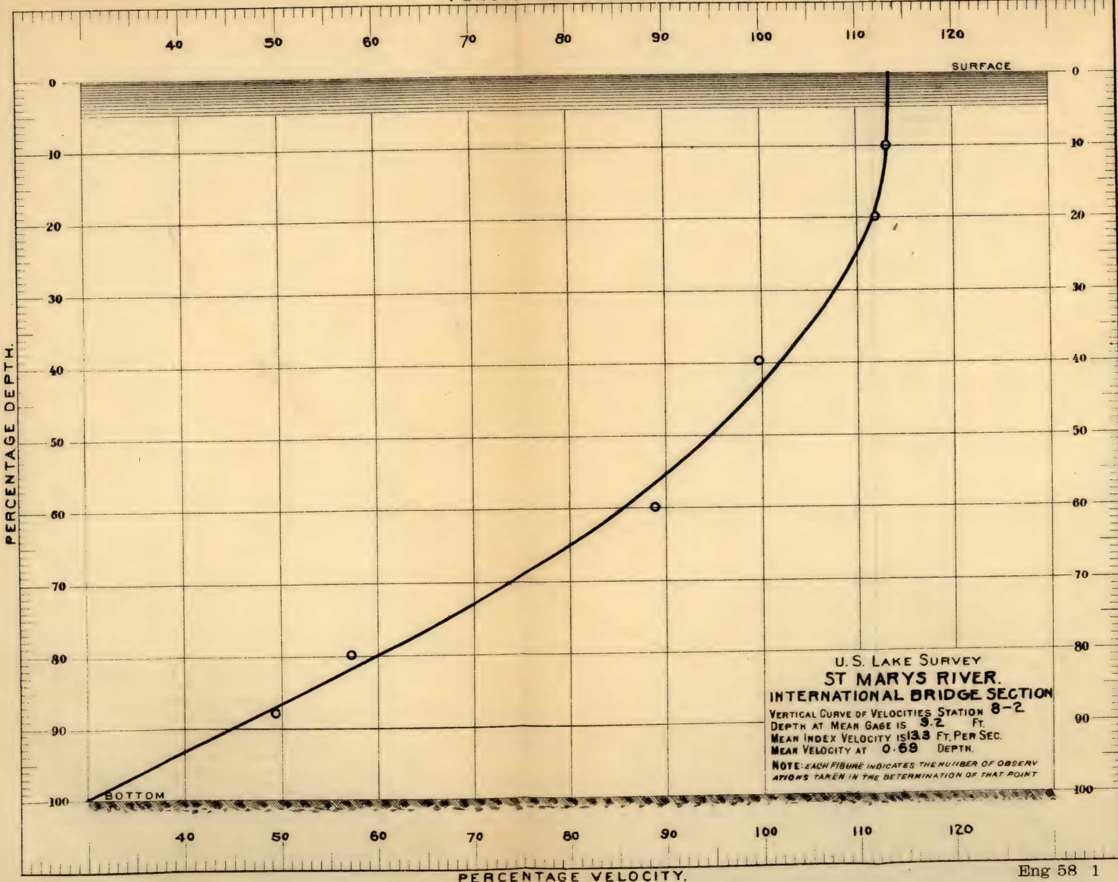
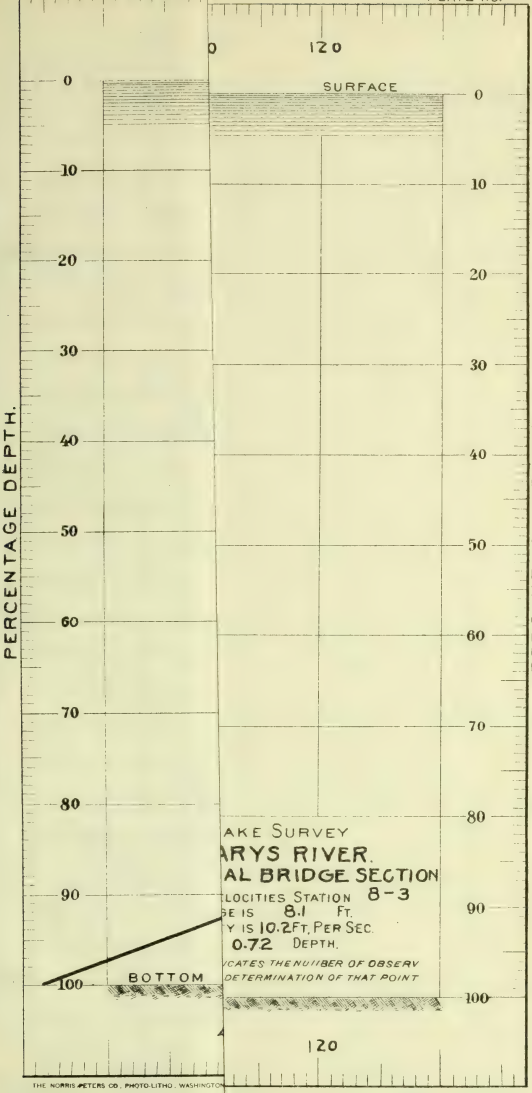

PERCENTAGE VELOCITY.
40 50 60 70 80 90 100 110 120
SURFACE
PERCENTAGE DEPTH.
0 10 20 30 40 50 60 70 80 90 100
BOTTOM
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 8-2
DEPTH AT MEAN GAGE IS 9.2 FT.
MEAN INDEX VELOCITY IS 13.3 FT. PER SEC.
MEAN VELOCITY AT 0.69 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT
PERCENTAGE VELOCITY.

PLATE No. 23.



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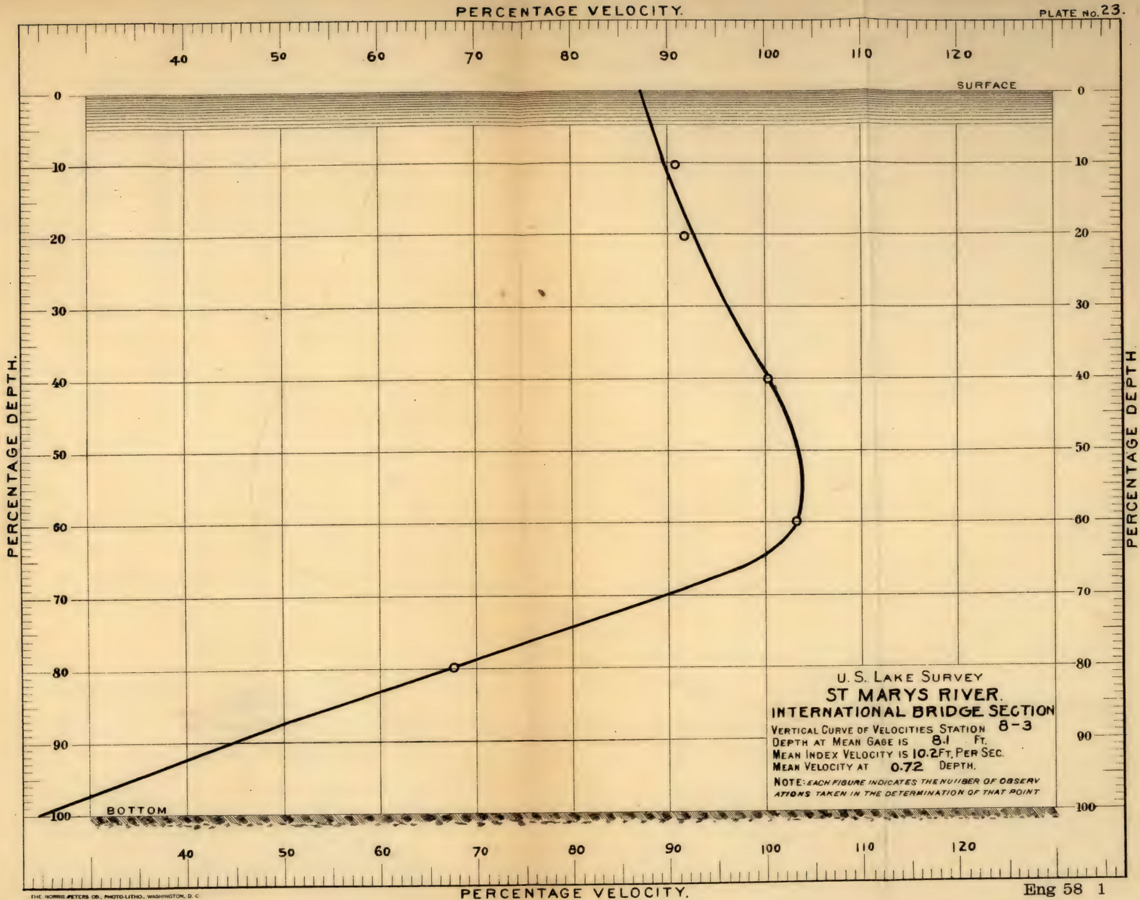
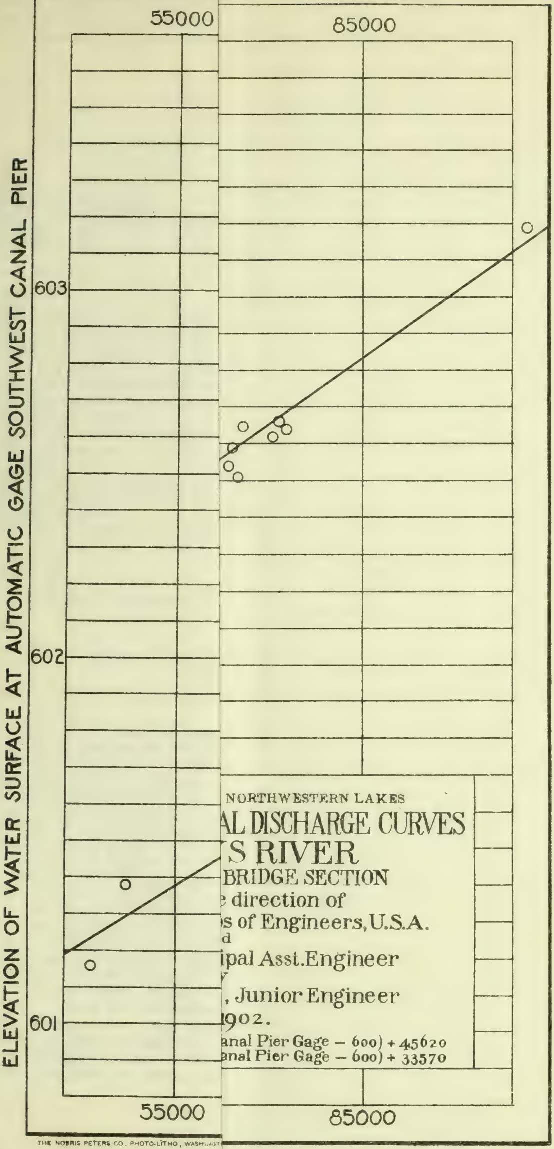
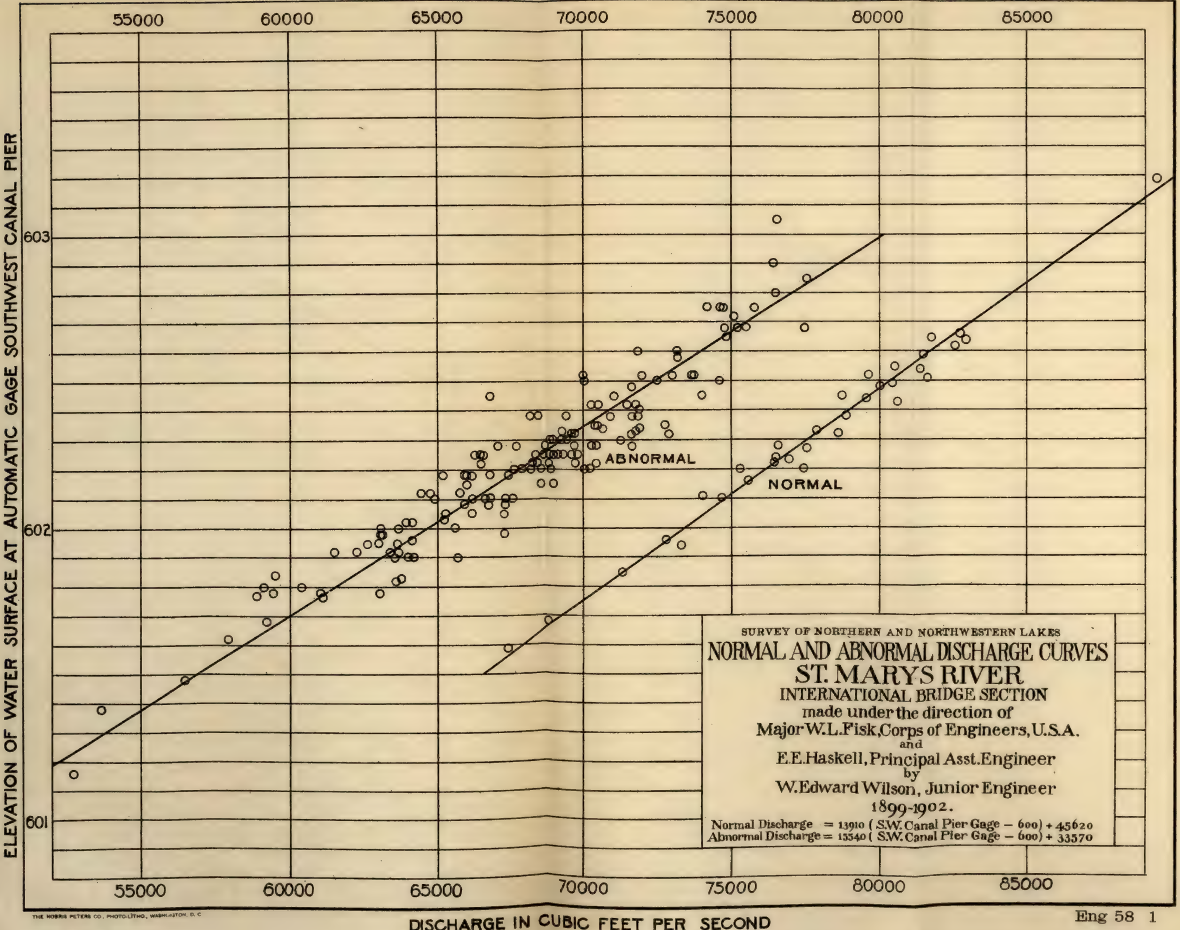

PERCENTAGE VELOCITY.
PERCENTAGE DEPTH.
SURFACE
BOTTOM
U. S. LAKE SURVEY
ST MARYS RIVER.
INTERNATIONAL BRIDGE SECTION
VERTICAL CURVE OF VELOCITIES STATION 8-3
DEPTH AT MEAN GAGE IS 8.1 FT.
MEAN INDEX VELOCITY IS 10.2 FT. PER SEC.
MEAN VELOCITY AT 0.72 DEPTH.
NOTE: EACH FIGURE INDICATES THE NUMBER OF OBSERVATIONS TAKEN IN THE DETERMINATION OF THAT POINT



55000
85000
ELEVATION OF WATER SURFACE AT AUTOMATIC GAGE SOUTHWEST CANAL PIER
603
602
601
NORTHWESTERN LAKES
AL DISCHARGE CURVES
S RIVER
BRIDGE SECTION
direction of
s of Engineers, U.S.A.
d
ipal Asst. Engineer
, Junior Engineer
1902.
anal Pier Gage − 600) + 45620
anal Pier Gage − 600) + 33570
55000
85000



55000
60000
65000
70000
75000
80000
85000
603
602
601
ELEVATION OF WATER SURFACE AT AUTOMATIC GAGE SOUTHWEST CANAL PIER
ABNORMAL
NORMAL
SURVEY OF NORTHERN AND NORTHWESTERN LAKES
NORMAL AND ABNORMAL DISCHARGE CURVES
ST. MARYS RIVER
INTERNATIONAL BRIDGE SECTION
made under the direction of
Major W.L.Fisk, Corps of Engineers, U.S.A.
and
E.E.Haskell, Principal Asst. Engineer
by
W.Edward Wilson, Junior Engineer
1899-1902.
Normal Discharge = 13910 (S.W. Canal Pier Gage – 600) + 45620
Abnormal Discharge = 15540 (S.W. Canal Pier Gage – 600) + 33570
DISCHARGE IN CUBIC FEET PER SECOND

The discharge through the auxiliary channels is approximately the same as given in my report of last year with the exception of the Canadian power plant, which has increased its discharge to 13,000 cubic feet per second.

A summary of these auxiliary discharges is shown in Table 13.

TABLE 13.

Outlet.	Discharge per second.	
	1901.	1902.
	Cubic ft.	*Cubic ft.*
Canadian power plant	5,000	13,000
Edison Sault power plant	700	700
Leakage through Edison Sault forebay	700	700
American locks	600	600
Canadian locks	150	150
Total	7,150	15,150

The total discharge of the St. Marys River is equal to the discharge of the St. Marys Rapids plus the auxiliary channel discharges.

As stated in my report of last year, the discharge equations might be in error 2 or 3 per cent, due to probable errors in the cross-section. By the determination of the new cross-section from the 1902 soundings and water-surface data, it is seen that the abnormal results of 1901 are about 3 per cent in error from the results determined in 1902.

In order to reduce the elevations given in this report to the 1903 adjusted elevations above mean tide at New York, a constant correction of +0.199 feet should be applied.

In closing this report I wish to express my appreciation to the members of the party for the careful and skillful manner in which they performed the duties assigned to them.

Very respectfully, your obedient servant,

W. EDWARD WILSON,
Junior Engineer.

Maj. W. L. FISK,
Corps of Engineers, U. S. Army.

REPORT OF MR. THOMAS RUSSELL, ASSISTANT ENGINEER.

OFFICE OF SURVEY OF NORTHERN AND NORTHWESTERN LAKES,
Detroit, Mich., March 24, 1903.

MAJOR: The following is a discussion of the discharge measurements of the St. Clair River made at the Dry Dock cross-section, 4.9 miles below Fort Gratiot lighthouse on Lake Huron, at entrance to river. The purpose of the discussion is to determine the effect of the varying levels of Lake Huron and Lake St. Clair in causing variations in the discharge.

The gauge readings showing heights of water surface in connection with the discharge measurements available for this purpose are the readings of the Grand Trunk Railway gauge on the St. Clair River, 0.8 of a mile from Lake Huron, where the river is 0.77 foot below the level of the lake, and the readings of Roberts Landing gauge, 26 miles from Lake Huron and 13.8 miles from Lake St. Clair at the head of the St. Clair Flats Canal. At Roberts Landing the river is 0.85 of a foot above the level of Lake St. Clair and 3.71 feet below the river at the Grand Trunk Railway gauge for a normal stage.

An approximate formula for the discharge in terms of the Grand Trunk Railway gauge and the St. Clair Flats Canal gauge is given in Report of Chief of Engineers for 1902, page 2821, based on discharges measured in 1899, 1900, and 1901. The formula derived here is based on these observations and others made in 1902. There are 240 measurements of discharge, of which 48 were made in 1902. They cover a range of 1.59 feet in the gauge at Grand Trunk Railway and 1.01 feet at Roberts Landing gauge.

The discharges were obtained from velocities measured at 0.5, 0.3, and 0.7 depths of the river with two meters at 21 stations, 100 feet apart, in connection with deter-

minations of the area of cross-section dependent on gauge readings made at the section. Factors were applied to the observed velocities to obtain the mean velocity throughout the depth of the river. The time required to make a complete discharge measurement was about four hours.

The whole process of measuring a discharge, rating the meters, determining the cross-section and vertical distribution of velocity is described in the reports for 1900 and 1902 and leave nothing to be desired in the accuracy of measurement.

The St. Clair River from Lake Huron to the Grand Trunk Railway gauge, a distance of 0.8 of a mile, has an average width of 1,015 feet and a depth of 37.1 feet for a height of Lake Huron of 580 feet. The difference of level between Lake Huron and the river at Grand Trunk Railway gauge is different at different times, even for the same reading of the Grand Trunk Railway gauge. While the average difference is 0.77 of a foot, it may be at times 0.10 of a foot greater or less than this and in some instances even more. In consequence of this the water comes out of Lake Huron with different velocities at different times, even with the same gauge reading at Grand Trunk Railway. The velocity is maintained past the Dry Dock section and throughout the river, modified by the varying slope and depths over the different stretches of the river.

For the same reading of Grand Trunk Railway gauge, therefore, there may be somewhat different quantities of water passing the Dry Dock section as the height of Lake Huron varies. Any formula based on the Grand Trunk Railway gauge readings is subject to some error when the varying head of the lake is not taken into account.

After the discharge observations had been begun in 1899 a gauge was established at Fort Gratiot light-house on Lake Huron. The inlet pipe becoming clogged with sand the gauge was discontinued in June, 1900. For 62 of the discharges, readings of the light-house gauge are available, but they do not cover enough range of gauge to be of use. For the observations made in 1902, readings of the Lexington gauge are available.

The discharges for which the heights of Lake Huron are known being too few to give a good determination of the formula for discharge the heights as given by the Grand Trunk Railway gauge are used. The record is missing for 16 discharges in 1902 on the following dates: August 26, September 2, 3, 4, 5, 6, 10, 12, 13, 16, and 18. For these dates the readings are supplied by applying to the Lexington gauge readings for the times of observation a constant 1.23 feet, equal to the difference between the Lexington and Grand Trunk Railway gauges on the days of discharge measurements when there were records for both. The distance from Lexington to the entrance to St. Clair River is 21 miles. Other dates for which this gauge record is missing are, in 1899, May 25, July 10, August 3, 5, 7, 8, 12, 14, 15: in 1900, July 7, November 30, and December 1. These were supplied from Sand Beach and Dry Dock gauges.

The gauge at Roberts Landing was established July 1, 1899. For the discharges previous to that time, April 29 to June 17, 23 in number, there are no heights of the river at that place available. For these dates the heights of the water were taken as given by the St. Clair Flats Canal guage with 0.9 of a foot added. Besides the dates mentioned the missing Roberts Landing gauge readings were supplied in a few other cases in the same way; these are July 12 and October 17, 1899, June 19 and September 4, 1900, August 25, and September 24, 25, 1902. The mean difference between the Roberts Landing and St. Clair Flats Canal gauges was 0.74 to 0.95 from June to November, 1899 to 1902.

For the 1902 discharges the Grand Trunk Railway and Roberts Landing gauge readings were taken for the exact times when the discharges were measured. In the case of the Grand Trunk Railway gauge, a reading was obtained for the times at each of the 21 stations, when the velocity was measured. The weighted mean of these was taken according to the quantity of water passing the section.

For the discharges observed in 1899, 1900, and 1901 the Grand Trunk Railway gauge readings given in report for 1902 are not for the times of observation at the Dry Dock section but for twelve minutes before the time. This is not considered to be correct. While corresponding wave phases or gauge heights may take twelve minutes to traverse the 4.1 miles from Grand Trunk Railway gauge to Dry Dock section, the pressure due to an increase of head, on which the velocity depends, increases almost immediately or at least after a time nearly the same as that required for transmission of sound in water, 4,708 feet per second.

The difference in Grand Trunk Railway gauge heights in twelve minutes would in most cases be small, not more than 0.01 of a foot; in some cases, however, it might amount to 0.05 of a foot. The gauge heights given in the 1902 report, for twelve minutes before the time of observation, are nevertheless retained in deriving the formula here, as the error introduced is small.

For the Roberts Landing gauge readings there is very little variation during the time of a discharge measurement. The straight mean for the times of observation at the various stations was taken without regard to weights for this gauge.

DESCRIPTION OF ST. CLAIR RIVER.

From Lake Huron to the Grand Trunk Railway gauge, a distance of 0.8 of a mile, the St. Clair River flows southwest. The river is comparatively narrow over this stretch, 1,015 feet wide on the average and 37.1 feet deep. The fall is 0.755 of a foot and the velocity relatively great.

From the Grand Trunk Railway gauge to Roberts Landing the river may be divided into eight well-marked stretches of nearly uniform width and depth.

From the Grand Trunk Railway gauge the river flows nearly southeast for 7,392 feet to the mouth of Black River; the average width and depth are 1,498 feet and 31 feet, and the fall 0.554 of a foot.

From Black River to Dry Dock section, 14,300 feet, the river flows southwest; the average width is 2,167 feet and the depth 27.3 feet. The fall is 0.375 of a foot.

At Dry Dock the river bends, flowing more nearly south, and for a distance of 17,952 feet to Marysville the average width is 2,078 feet and the depth 29.6 feet. The fall is 0.491 of a foot.

From Marysville to St. Clair the river flows nearly south for 30,096 feet. The average width is 3,002 feet and the depth 24.3 feet. The fall is 0.786 of a foot. In this stretch Stag Island divides the river into two channels for a distance of 1¼ miles.

From St. Clair to a point 20,000 feet below to (a) the river flows south, slightly toward the east, with an average width of 1,828 feet and a depth of 34.3 feet. The computed fall is 0.473 of a foot.

From the point (a) to Marine City the river flows a little west of south for 21,120 feet with an average width of 2,984 feet and a depth of 25.6 feet. The computed fall is 0.448 of a foot.

From Marine City to a point (b) 12,000 feet below, the river flows southwest with an average width of 3,135 feet and depth of 25.1 feet. The computed fall is 0.214 of a foot. In this stretch Woodtick or Fawn Island divides the river into two channels for a distance of one-half mile.

From the point (b) to Roberts Landing, 10,032 feet, the river flows between south and southwest with an average width of 2,289 feet and a depth of 29.9 feet. This average width and depth includes 6,000 feet of the river below Roberts Landing. The computed fall is 0.197 of a foot.

The first distributary from the river is Chenal Écarté, 7,000 feet below Roberts Landing. At Russell Island, 16,000 feet below Roberts Landing, the river divides, going to Lake St. Clair through North Channel by Algonac and through South Channel to St. Clair Flats Canal.

The differences of level given above are for a height of Lake Huron of 580.479 feet at Sand Beach and depend on observations of water level made on six days in June, 1899, at ten-minute intervals, from 7 a. m. to 5.30 p. m. (Report for 1900, p. 5365.)

The height of river at Roberts Landing for the same time is derived as 576.186, considering the level of river to fall uniformly from Marine City gauge, 21.8 miles below Fort Gratiot light-house, to the Algonac gauge 29.1 miles. The distance from light-house to Roberts Landing is 26 miles.

From St. Clair to the point (a) and (a) to Marine City the falls were derived by dividing the fall between the St. Clair and Marine City gauges into two parts according to the lengths of the parts and a ratio of slopes dependent on the velocities and depths in the two parts. The discharge divided by average cross section gives the velocity; the velocities are proportional to the square roots of the depths and slopes.

The same kind of a division of fall between Marine City and Roberts Landing was made for its parts Marine City to (b) and (b) to Roberts Landing.

These details are summarized in Table I following. The sketch after Table I shows the stretches into which the river has been divided.

To determine the relation of discharge to varying heights of the river it will first be necessary to determine the normal relation of the Grand Trunk Railway and Roberts Landing gauges. As these have been only recently established, the relation will have to be derived indirectly through Lakes Huron and St. Clair, for which there are long records.

The level of Lake St. Clair is controlled by Lake Huron and Lake Erie. With a uniform supply of water to Lake Huron and with uniform evaporation, and, in the case of Lake Erie, with a uniform supply from the Lake Erie drainage area

proper and with a uniform evaporation and constant outflow, the discharge through St. Clair River would become constant in the course of time and the levels of Lakes Huron and St. Clair stationary.

If Lake Huron is above the normal level, Lake St. Clair being at the normal, the discharge of the river will be greater than the supply, and as the level of the lake falls the discharge will gradually diminish until the normal is reached, when the discharge will become constant. If Lake Huron is below the normal, St. Clair being at the normal, the supply being greater than the discharge, the level of Lake Huron will gradually rise and, the discharge increasing with the rise until it becomes equal to the supply, the level will become stationary and the discharge constant.

TABLE I.—*St. Clair River characteristic stretches—Elevation of water surface above mean tide at New York, bench mark Fort Gratiot 589.90 (1877), for discharge 204,505 cubic feet per second.*

Stretch.	Station.	Distance below Fort Gratiot light-house.	Length of stretch.		Depth.	Width.	Cross section.	Velocity.	June, 1899, six days.	Fall.	Slope per foot.
		Miles.	Miles.	Feet.	Feet.	Feet.	Sq. feet.	Feet per sec.	Feet.	Feet.	Feet.
	Lake Huron								580.479		
			0.90	4,224	37.1	1,015	37,650	5.432		0.755	0.0001787
	G. T. R. gauge	0.80							579.724		
1			1.40	7,392	31.0	1,498	46,330	4.414		.554	.0000749
	Kendalls	2.20							579.170		
2			2.70	14,300	27.3	2,167	59,050	3.463		.375	.0000262
	Dry Dock	4.90							578.795		
3			3.40	17,952	29.6	2,078	61,509	3.325		.491	.0000273
	Marysville	8.30							578.304		
4			5.70	30,096	24.3	3,002	72,949	2.803		.786	.0000261
	St. Clair	14.00							577.518		
5			3.80	20,000	34.3	1,828	62,700	3.262		.473	.0000236
	A	17.80							577.045		
6			4.00	21,120	25.6	2,984	76,390	2.677		.448	.0000212
	Marine City	21.80							576.597		
7			2.30	12,000	25.1	3,135	78,688	2.599		.214	.0000178
	B	24.10							576.383		
8			1.90	10,032	29.9	2,289	68,441	2.988		.197	.0000196
	Roberts Landing	26.00							576.186		
			13.80	72,864						.840	.0000115
	St. Clair Flats Canal	39.80							575.346		

When the level of Lake St. Clair is below the normal, Lake Huron being at the normal, the discharge of St. Clair River is greater than the average. As the level of Lake St. Clair rises the discharge diminishes; when the normal is reached the discharge becomes constant and the level stationary.

The levels of the lakes are in a continual state of fluctuation from irregularities in the supply and evaporation.

For any particular level of Lake Huron considered as a normal there is a corresponding normal level of Lake St. Clair. The difference is probably different for different levels of Lake Huron.

The levels are oscillating about the normal levels in a series of years probably as often above as below them.

The means of the levels for a series of years may be taken without much error as the normals for the average supply of water coming into the lakes during those years.

The mean difference of level of Lakes Huron and St. Clair for twenty-seven years, 1873 to 1899, June to November, inclusive, is 5.373 feet. This is adopted as the normal difference of heights. The mean height of Lake Huron for the same time was 581.233 feet. The mean for June to November, 1876, was as high as 582.82 and for 1896 as low as 579.37. (Report for 1900, p. 5394.)

In June, 1899, about the time the discharge observations began, the level of Lake Huron was 580.479 and the corresponding level at the Grand Trunk Railway gauge was 579.724. These were the means of corresponding readings made on six days at ten-minute intervals from 7 a. m. to 5.30 p. m. (Report for 1900, p. 5365.) The Lake Huron level is by Sand Beach gauge.

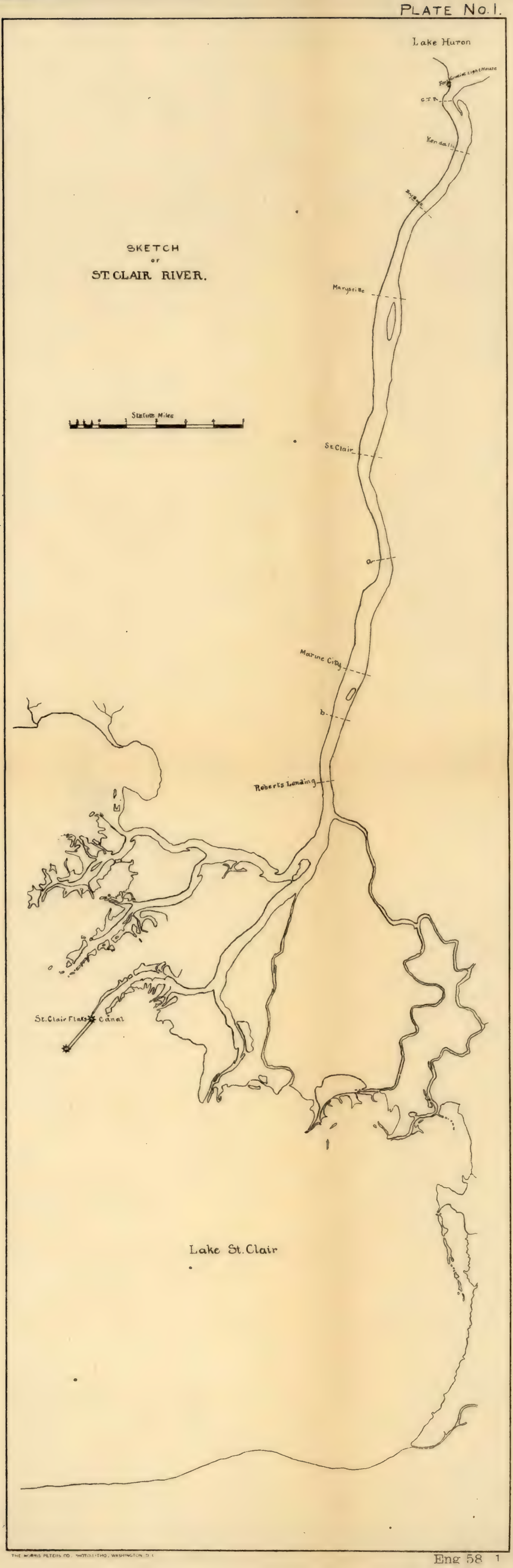
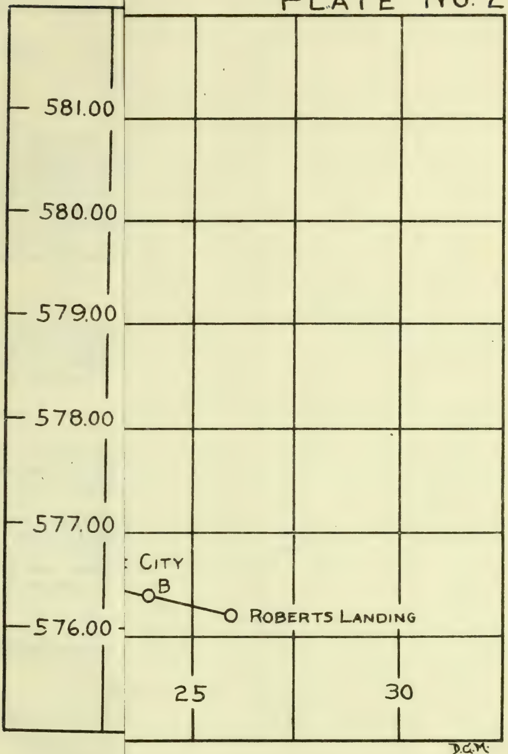

Lake Huron
Fort Gratiot Light House
G.T.R.
Kendalls
SKETCH
of
ST. CLAIR RIVER.
Statute Miles
Marysville
St. Clair
a
Marine City
b
Roberts Landing
St. Clair Flats Canal
Lake St. Clair

PLATE No. 2.



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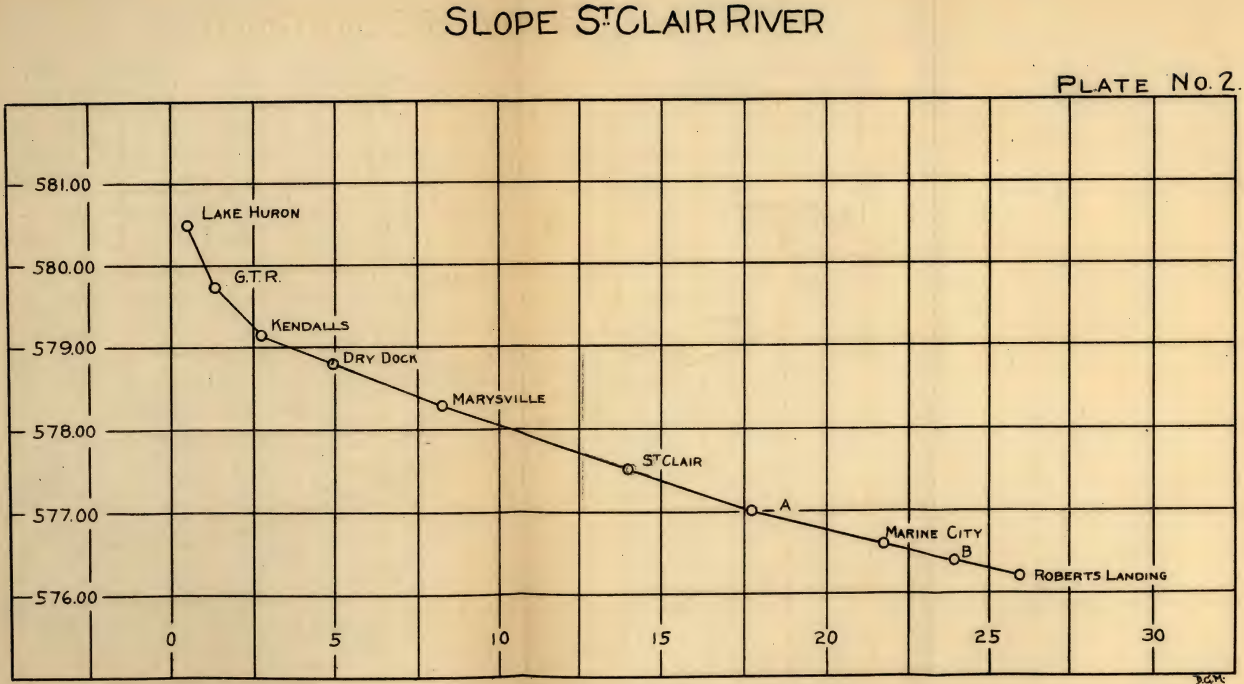

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SCALE

HORIZONTAL = 0.23 INCH TO 1 MILE.

VERTICAL = 0.58 INCH TO 1 FOOT.

NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

The normal level for Lake St. Clair, corresponding to the height of 580.48 for Lake Huron, is 5.37 feet less, or 575.11 feet. Adding 0.90 to the height of Lake St. Clair to obtain the height at Roberts Landing, it becomes 576.01.

The normal heights adopted are then—

Grand Trunk Railway gauge, 579.72.
Roberts Landing gauge, 576.01.

These heights depend on the height of bench mark "Fort Gratiot" 589.90 feet above mean tide at New York (1877).

Before deriving the formula for the discharge from the observations it will be deduced theoretically. The Chezy formula for the flow of water is:

$$v=c\sqrt{RS} \qquad \text{. . . . (1)}$$

in which,

v=velocity.
R=hydraulic radius.
S=slope of surface.
c=constant depending on nature of stream.

In applying the formula the St. Clair River will be taken as uniform in width and depth and equal to the average from the Grand Trunk Railway gauge to Roberts Landing. The mean width from measurements made 2,000 feet apart on the detail sheets of the recent survey is 2,430 feet and the depth 28 feet.

The approximate discharge derived from the formula in report for 1902, page 2821 for Grand Trunk Railway gauge 579.72 and Lake St. Clair 575 is 209,450 cubic feet per second.

The average velocity of the river is then:

$$v=\frac{209450}{2430\times28}=3.078$$

For the hydraulic radius R, the depth of the river, 28 feet may be taken, as the river is wide compared with the depth. The slope S, the difference in level at the two points of river, is 3.71 feet. Substituting these numbers in the Chezy formula it becomes:

$$v=3.078=c\sqrt{28\times3.71}=c10.192 \qquad \text{. . . . (2)}$$

whence:

$$c=0.3020$$

This value of c results from using the slope for 25.2 miles, the distance between the gauges, and not the value of the slope per foot or per mile.

For small variations in the height of the river the value of c may be considered constant.

Let the height of the river at the Grand Trunk Railway gauge change by a quantity H and the height at Roberts Landing by h and let the resulting velocity in the river be denoted by v^1. Then the new hydraulic radius will be $28+\frac{1}{2}(H+h)$ and the new slope will be $3.71+(H+h)$. Substituting these in the Chezy formula it becomes:

$$v^1=c\sqrt{\left(28+\frac{1}{2}(H+h)\ \ (3.71+(H-h)\right)} \qquad \text{. . . (3)}$$

Expanding the factors under the radical sign by the binomial theorem

$$(a+b)^n=a^n+n\,a^{n-1}b+\frac{n(n-1)}{1.2}a^{n-2}b^2+\text{ etc.}$$

there results for the first:

$$\left(28+\frac{1}{2}(H+h)\right)^{\frac{1}{2}}=28^{\frac{1}{2}}+\frac{1}{2}\,28^{-\frac{1}{2}}\frac{1}{2}(H+h)-\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}\,28^{-\frac{3}{2}}\,\frac{1}{4}(H+h)^2+\text{ etc.}$$

$$=5.29+\frac{1}{2}\,\frac{1}{5.29}\,\frac{1}{2}(H+h)-\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}\,\frac{1}{148}\,\frac{1}{4}(H+h)^2+\text{ etc.}$$

$$=5.29+\frac{1}{21.16}(H+h)-\frac{1}{4736}(H+h)^2+\text{ etc.} \qquad \text{. . (4)}$$

and for the second:

$$\left(3.71+(H-h)\right)^{\frac{1}{2}}=3.71^{-\frac{1}{2}}+\frac{1}{2}\,3.71^{-\frac{1}{2}}(H-h)-\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}3.71^{-\frac{3}{2}}(H-h)^2+\text{ etc.}$$

$$=1.93+\frac{1}{3.86}(H-h)-\frac{1}{57.12}(H-h)^2+\text{ etc.} \qquad \text{. . (5)}$$

The coefficient of $(H+h)^2$ being small $\frac{1}{4736}$ in the first and also that of $(H-h)^2$ in the second $\frac{1}{57.12}$; these may be neglected in the development and the formula becomes:

$$v^1=c\left(5.29+\frac{1}{21.16}(H+h)\right)\left(1.93+\frac{1}{3.86}(H-h)\right) \quad . \; . \; . \quad (6)$$

Carrying out the multiplication, it becomes:

$$v^1=c\left(10.21+1.461H-1.279h+\frac{1}{81.68}(H^2-h^2)\right) \quad . \; . \; . \quad (7)$$

For the changes in height H and h the new mean depth of river is

$$28+\frac{1}{2}(H+h)$$

and the new cross section:

$$\left(28+\frac{1}{2}(H+h)\right)2430$$

The change in height of river makes only a slight change in width, the banks being steep.

The new discharge for change in height H and h is the new velocity v^1 multiplied by the new cross section, or:

$$c\left(10.21+1.461H-1.279h+\frac{1}{81.68}(H^2-h^2)\right)\left(28+\frac{1}{2}(H+h)\right)2430$$

The old discharge is the old velocity v equation (2) multiplied by the old cross-section, or

$$c10.192\ (2430)\ (28)$$

The difference between the new and old discharge is:

$$c\times2430\times28\left(10.21+1.461H-1.279h+\frac{1}{81.68}(H^2-h^2)\right)$$
$$+c\times2430\times\frac{1}{2}(H+h)\left(10.21+1.461H-1.279h+\frac{1}{81.68}(H^2-h^2)\right)$$
$$-c\times2430\times28\times10.192.$$

Substituting for c the value given above, $c=0.30204$, the difference denoted by I is:

$$I=+33772H-22537h+67Hh+787H^2-720h^2 \quad . \; . \; . \; . \; . \quad (8)$$

The slope of river diminishes rapidly from Lake Huron to Roberts Landing, as may be seen from Table I and from the curve on following page, in which the abscissas are distances from Lake Huron and the ordinates heights of water surface. On account of the great diminution of slope and varying width and depth of river over different stretches, it is advisable to derive the theoretical formula for the discharge, taking these into account.

The following notation is adopted:

H=change of G. T. R. gauge from 579.724.
x_1=change at Kendalls.
x_2=change at Dry Dock.
x_3=change at Marysville.
x_4=change at St. Clair.
x_5=change at a.
x_6=change at Marine City.
x_7=change at b.
h =change at Roberts Landing from 576.186.

Denoting the velocities in the various stretches by v_1, v_2, v_3, v_4, v_5, v_6, v_7, and v_8, and the corresponding values of constant in the Chezy formula by c_1, c_2, c_3, etc., to c_8, the following expressions are obtained for the velocities:

$$v_1=c_1\sqrt{\left(31.0+\frac{1}{2}(H+x_1)\right)\left(0.554+(H-x_1)\right)}$$

$$v_2=c_2\sqrt{\left(27.3+\frac{1}{2}(x_1+x_2)\right)\left(0.375+(x_1-x_2)\right)}$$

$$v_3=c_3\sqrt{\left(29.6+\frac{1}{2}(x_2+x_3)\right)\left(0.491+(x_2-x_3)\right)}$$

$$v_4=c_4\sqrt{\left(24.3+\frac{1}{2}(x_3+x_4)\right)\left(0.786+(x_3-x_4)\right)}$$

$$v_5=c_5\sqrt{\left(34.3+\frac{1}{2}(x_4+x_5)\right)\left(0.473+(x_4-x_5)\right)}$$

$$v_6=c_6\sqrt{\left(25.6+\frac{1}{2}(x_5+x_6)\right)\left(0.448+(x_5-x_6)\right)}$$

$$v_7=c_7\sqrt{\left(25.1+\frac{1}{2}(x_6+x_7)\right)\left(0.214+(x_6-x_7)\right)}$$

$$v_8=c_8\sqrt{\left(29.9+\frac{1}{2}(x_7+h)\right)\left(0.197+(x_7-h)\right)}$$

After the changes in gauge readings the new values of the cross sections in the different stretches are as follows:

Stretch.	Cross sections.
1	$1498\left(31.0+\frac{1}{2}(H+x_1)\right)$
2	$2167\left(27.3+\frac{1}{2}(x_1+x_2)\right)$
3	$2078\left(29.6+\frac{1}{2}(x_2+x_3)\right)$
4	$3002\left(24.3+\frac{1}{2}(x_3+x_4)\right)$
5	$1828\left(34.3+\frac{1}{2}(x_4+x_5)\right)$
6	$2984\left(25.6+\frac{1}{2}(x_5+x_6)\right)$
7	$3135\left(25.1+\frac{1}{2}(x_6+x_7)\right)$
8	$2289\left(29.9+\frac{1}{2}(x_7+h)\right)$

The values of c_1, c_2, etc., to c_8, are taken to be the same after the change as before. The numerical values are derived from the Chezy formula, using the values of v in Table I, derived from the discharge of 204,505 cubic feet per second for a stage of 579.72 at G. T. R. gauge and 576.186 at Roberts Landing.

Multiplying the new cross sections by the new velocities and substituting the numerical values for c_1, c_2, etc., to c_8, eight expressions are obtained for the discharge. Subtracting the value of discharge given above for G. T. R. 579.72 and Roberts Landing 576.186, the following expressions are derived for the change in discharge after developing and neglecting the second and higher powers of the differences and sums of gauge changes. The change in discharge is denoted by I.

$$I=+189636H-179768x_1$$
$$I=+278143x_1-266932x_2$$
$$I=+213512x_2-203179x_3$$
$$I=+136436x_3-123805x_4$$
$$I=+220741x_4-211828x_5$$
$$I=+234244x_5-222274x_6$$
$$I=+483581x_6-471363x_7$$
$$I=+524081x_7-513864h$$

Solving these equations I, x_1, x_2, x_3, x_4, x_5, x_6, and x_7 are obtained in terms of H and h as follows:

$$\left.\begin{aligned}
I&=+34628H-23704h\\
x_1&=+0.862H+0.132h\\
x_2&=+0.769H+0.226h\\
x_3&=+0.637H+0.354h\\
x_4&=+0.423H+0.581h\\
x_5&=+0.277H+0.718h\\
x_6&=+0.136H+0.863h\\
x_7&=+0.066H+0.935h
\end{aligned}\right\} \quad \cdots\cdots\cdots\cdots \quad (9)$$

The coefficient of H found by considering the river of uniform width, depth, and slope was 33772 and that of h -22537.

For a given change at Grand Trunk Railway gauge H and at Roberts Landing gauge h the values of x_1, x_2, etc., can be computed from the above, which, applied to the readings at Kendalls and Dry Dock, etc., given in Table I, will give the corresponding readings at those places.

Equation (8) shows the form equation should have to give change in discharge for a change in height at Grand Trunk Railway gauge and at Roberts Landing.

The discharge observations will be used to determine the coefficients of H and h. There is not enough range in stages to give a good determination of the coefficients of H^2 and h^2. The term in Hh is so small it may be neglected.

Calling D the discharge when the Grand Trunk Railway gauge is 579.72 and the Roberts Landing gauge 576.00, and calling A the coefficient of H and B the coefficient of h, then every observation of discharge will give an equation of the form:

$D+HA+hB-n=v.$
D=discharge for G. T. R. 579.72, Roberts Landing 576.00.
H=G. T. R. minus 579.72.
h =Roberts Landing minus 576.00.
A=change for one foot at G. T. R.
B=change for one foot at Roberts Landing.
n =observed discharge in units of 100 cubic feet.
v =residual computed minus observed in units of 100 cubic feet.

The following are the observation equations:

Observation equations, St. Clair River discharge.

						v	Wind. Direction.	Wind. Miles per hour.
1899.								
Apr. 29	D	$-0.87\ A$	$-0.25\ B$	-1880	=	-99	S.	10
May 1	D	-0.97	-0.25	-1836	=	-96	SE.	20
3	D	-0.97	-0.2	-1912	=	-30	NE.	15
4	D	-0.76	-0.2	-1897	=	-81	E.	9
5	D	-0.70	-0.2	-1909	=	-68	W.	7
6	D	-0.68	-0.2	-1942	=	-93	S.	[illegible]
23	D	-0.39	-0.0	-2016	=	-91	N.	10
25	D	-0.54	-0.0	-1940	=	-78	SW.	14
29	D	-0.48	$+0.05$	-1944	=	-68	S.	16
31	D	-0.58	$+0.05$	-1865	=	-30	S.	18
June 2	D	-0.28	$+0.1$	-2042	=	-94	N.	14
3	D	-0.41	$+0.1$	-1990	=	-97	E.	8
5	D	-0.33	$+0.12$	-1960	=	-37	SW.	18
6	D	-0.29	$+0.13$	-2033	=	-96	SW.	12
7	D	-0.34	$+0.20$	-1964	=	-63	S.	16
8	D	-0.15	$+0.2$	-2067	=	-87	NW.	10
10	D	-0.16	$+0.2$	-2059	=	-84	N.	8
12	D	-0.33	$+0.2$	-1944	=	-39	S.	20
13	D	-0.34	$+0.2$	-1939	=	-38	S.	18
14	D	-0.22	$+0.2$	-1942	=	$+9$	S.	17
15	D	-0.08	$+0.2$	-2023	=	-14	NW.	13
16	D	$+0.09$	$+0.2$	-2108	=	-29	NW.	12
17	D	-0.06	$+0.2$	-2051	=	-34	N.	8
July 10	D	$+0.13$	$+0.27$	-2071	=	$+9$	SW.	10
11	D	$+0.16$	$+0.28$	-2106	=	-15	W.	10

Observation equations, St. Clair River discharge—Continued.

						v	Wind. Direction.	Wind. Miles per hour.
1899.								
July 12	D	+0.13 A	+0.26 B	−2118	=	−36	N.	12
15	D	+0.07	+0.30	−2053	=	− 5	SE.	10
17	D	+0.33	+0.37	−2189	=	−49	NW.	15
18	D	+0.17	+0.33	−2068	=	+15	NW.	13
19	D	+0.23	+0.32	−2072	=	+39	NW.	10
20	D	+0.10	+0.27	−2039	=	+29	SE.	14
22	D	+0.20	+0.32	−2109	=	−11	NW.	12
24	D	+0.13	+0.33	−2060	=	+ 6	N.	9
25	D	+0.13	+0.31	−2068	=	+ 3	NW.	9
26	D	+0.07	+0.30	−1967	=	+81	S.	12
27	D	+0.27	+0.36	−2093	=	+25	NE.	10
28	D	+0.16	+0.31	−2053	=	+31	SW.	9
29	D	+0.16	+0.36	−2082	=	− 9	S.	18
Aug. 3	D	+0.19	+0.30	−2063	=	+35	S.	6
5	D	+0.22	+0.30	−2060	=	+50	W.	6
7	D	+0.23	+0.34	−2099	=	+ 7	N.	10
8	D	+0.17	+0.33	−2083	=	0	N.	10
12	D	+0.12	+0.33	−2031	=	+31	SW.	17
14	D	+0.12	+0.29	−2105	=	−34	N.	15
15	D	+0.13	+0.29	−2109	=	−34	N.	15
16	D	+0.09	+0.28	−2054	=	+ 7	N.	10
22	D	+0.30	+0.33	−2170	=	−33	NW.	12
23	D	+0.07	+0.23	−2067	=	− 3	NW.	10
24	D	−0.04	+0.20	−2003	=	+22	S.	10
28	D	−0.01	+0.20	−2069	=	−31	N.	13
29	D	−0.02	+0.19	−2041	=	− 5	E.	10
30	D	−0.16	+0.13	−1999	=	− 8	SE.	11
31	D	−0.10	+0.14	−2007	=	+ 6	E.	9
Sept. 1	D	−0.16	+0.16	−2019	=	−35	N.	7
6	D	−0.04	+0.15	−2028	=	+ 8	N.	10
7	D	−0.32	+0.06	−1925	=	+15	S.	12
8	D	−0.00	+0.15	−2064	=	−11	NW.	5
9	D	−0.02	+0.14	−2043	=	+ 4	NW.	8

						v	Wind. Direction.	Wind. Miles per hour.	Light-house minus G. T. R.
1899.									
Sept. 14	D	−0.01 A	+0.11 B	−2059	=	− 1	SE.	8	
22	D	−0.13	+0.06	−2049	=	−30	NW.	8	
Oct. 10	D	−0.81	−0.35	−1809	=	+20	SE.	16	0.62
11	D	−0.64	−0.31	−1900	=	− 9	S.	13	0.65
13	D	−0.78	−0.38	−1845	=	+ 4	S.	15	0.62
14	D	−0.24	−0.22	−2092	=	−55	NW.	18	0.69
16	D	−0.92	−0.43	−1803	=	− 2	S.	16	0.61
17	D	−0.35	−0.25	−1987	=	+10	NW.	7	0.70
18	D	−0.50	−0.29	−1944	=	+ 1	SW.	13	0.67
19	D	−0.38	−0.26	−1976	=	+12	N.	9	0.65
20	D	−0.41	−0.26	−2004	=	−29	NE.	12	0.64
23	D	−0.80	−0.40	−1830	=	+14	SE.	14	0.66
27	D	−0.46	−0.32	−1988	=	−20	NE.	9	0.72
27	D	−0.54	−0.33	−1969	=	−32	NE.	10	0.71
28	D	−0.38	−0.20	−1946	=	+28	NW.	10	0.67
28	D	−0.33	−0.18	−1963	=	+28	N.	10	0.68
Nov. 1	D	−0.12	−0.17	−2072	=	+ 3	N.	19	0.79
1	D	−0.12	−0.20	−2125	=	−43	N.	19	0.86
3	D	−0.38	−0.40	−2049	=	−30	NE.	17	0.78
15	D	−0.80	−0.40	−1857	=	−13	SW.	10	
16	D	−0.75	−0.47	−1876	=	+ 5	E.	10	0.68
17	D	−1.29	−0.63	−1740	=	−48	SE.	17	0.61
21	D	−1.03	−0.58	−1803	=	−13	S.	18	0.62
23	D	−0.68	−0.55	−1952	=	−24	NE.	17	0.71
24	D	−0.74	−0.54	−1929	=	−28	E.	4	0.60

Observation equations, St. Clair River discharge—Continued.

						v	Wind. Direction.	Wind. Miles per hour.	Light-house minus G. T. R.
1899.									
Nov. 27	D	−0.84 A	−0.54 B	−1865	=	− 5	SW.	6	0.63
28	D	−0.82	−0.47	−1854	=	− 2	SW.	15	0.59
29	D	−0.90	−0.57	−1814	=	+28	SW.	12	0.60
Dec. 1	D	−1.00	−0.44	−1779	=	− 9	SW.	20	
2	D	−0.61	−0.33	−1908	=	0	SW.	16	0.60
4	D	−0.48	−0.45	−2009	=	−20	NW.	20	0.71
6	D	−0.54	−0.51	−1988	=	−11	NW.	2	0.75
1900.									
June 19	D	−0.52	−0.18	−1944	=	−32	NE.	12	0.69
20	D	−0.59	−0.19	−1917	=	−32	NE.	10	0.84
21	D	−0.64	−0.21	−1882	=	−14	SW.	12	0.61
22	D	−0.56	−0.16	−1903	=	−13	E.	12	0.64
25	D	−0.47	−0.11	−1914	=	+ 3	NE.	10	0.66
29	D	−0.32	−0.05	−1929	=	+36	NW.	18	0.66
30	D	−0.30	−0.07	−1964	=	+14	NW.	17	0.70
July 2	D	−0.64	−0.19	−1824	=	+40	S.	12	0.60
3	D	−0.60	−0.11	−1825	=	+37	SW.	20	0.60
5	D	−0.63	−0.16	−1822	=	+39	SW.	14	0.60
7	D	−0.32	−0.03	−1911	=	+50	SW.	16	0.64
7	D	−0.44	−0.09	−1907	=	+17	SW.	11	0.64
23	D	−0.25	+0.06	−1894	=	+75	SW.	7	0.64
24	D	−0.20	+0.09	−1912	=	+72	NW.	13	0.67
24	D	−0.26	+0.04	−1905	=	+65	NE.	9	0.68
25	D	−0.10	+0.15	−1979	=	+32	N.	18	0.72
26	D	−0.05	+0.20	−2009	=	+12	NE.	10	0.72
26	D	−0.07	+0.14	−1991	=	+35	NE.	16	0.77
28	D	−0.26	+0.09	−1933	=	+26	SW.	9	0.65
28	D	−0.24	+0.08	−1943	=	+26	SW.	12	0.66
31	D	−0.06	+0.20	−1993	=	+24	NW.	12	0.68
Aug. 1	D	−0.21	+0.13	−1950	=	+21	NE.	9	0.72
2	D	−0.28	+0.15	−1892	=	+45	SW.	10	0.64
2	D	−0.18	+0.11	−1964	=	+23	SW.	7	0.64
4	D	−0.42	+0.03	−1882	=	+23	SW.	10	0.69
4	D	−0.44	+0.02	−1869	=	+30	SW.	11	0.67
6	D	−0.35	+0.03	−1929	=	+ 5	W.	12	0.69
8	D	−0.26	+0.08	−1938	=	+23	NW.	15	0.71
8	D	−0.23	+0.09	−1929	=	+42	NW.	17	0.69
27	D	−0.23	+0.16	−1910	=	+45	SW.	12	0.71
Sept. 4	D	−0.16	+0.10	−1951	=	+46	E.	9	0.70
4	D	−0.20	+0.10	−1931	=	+50	NE.	8	0.72
10	D	−0.36	+0.06	−1916	=	+ 7	SW.	8	
10	D	−0.36	+0.05	−1904	=	+22	SW.	7	
12	D	+0.10	+0.18	−2006	=	+82	NW.	20	
14	D	−0.14	+0.10	−1969	=	+37	NE.	11	
17	D	+0.23	+0.19	−2090	=	+50	NW.	25	
18	D	−0.26	−0.00	−1970	=	+ 9	E.	9	
19	D	−0.46	−0.08	−1857	=	+57	SE.	14	
19	D	−0.50	−0.10	−1873	=	+29	SE.	10	
Nov. 8	D	−0.59	−0.31	−1916	=	− 4	NW.	12	
9	D	−0.38	−0.22	−1986	=	− 7	NW.	20	
10	D	−0.41	−0.28	−1984	=	− 5	SW.	7	
13	D	−0.24	−0.16	−2034	=	−11	NW.	16	
15	D	−0.34	−0.22	−2005	=	− 9	NW.	20	0.78
16	D	−0.52	−0.36	−1972	=	−20	SW.	10	0.78
30	D	−0.70	−0.25	−1825	=	+27	SW.	20	
Dec. 1	D	−0.48	−0.34	−1966	=	− 2	NW.	12	
3	D	−0.61	−0.38	−1912	=	+ 7	SW.	10	
4	D	−0.55	−0.40	−1960	=	−12	NW.	12	
5	D	−0.34	−0.28	−2011	=	− 2	NW.	16	
6	D	−0.53	−0.34	−1902	=	+42	SW.	12	
7	D	−0.34	−0.34	−2024	=	− 1	NE.	8	
8	D	−0.77	−0.44	−1856	=	+ 4	SW.	12	
10	D	−0.32	−0.19	−2018	=	−21	NW.	16	
11	D	−0.29	−0.19	−2045	=	−36	NW.	20	
13	D	−0.03	−0.15	−2141	=	−32	NW.	25	

Observation equations, St. Clair River discharge—Continued.

							Wind.		Light-house minus G. T. R.
						v	Direction.	Miles per hour.	
1900.									
Dec. 15	D	−0.63 A	−0.40 B	−1938	=	−23	SE.	6	
17	D	−0.94	−0.40	−1835	=	−49	SE.	16	
18	D	−0.92	−0.40	−1821	=	−27	SE.	15	
19	D	−0.72	−0.34	−1853	=	+12	SW.	15	
20	D	−0.49	−0.35	−1984	=	−22	NW.	10	
21	D	−1.04	−0.54	−1759	=	+17	S.	18	
22	D	−1.22	−0.64	−1742	=	−17	SW.	25	
26	D	−0.73	−0.60	−1942	=	−23	NW.	10	
27	D	−0.97	−0.63	−1797	=	+29	SW.	16	
1901.									
May 14	D	−0.30	−0.58	−2112	=	−19	NE.	12	
15	D	−0.29	−0.55	−2107	=	−17	N.	12	
17	D	−0.35	−0.53	−2060	=	+ 1	SW.	7	
18	D	−0.27	−0.53	−2135	=	−40	N.	20	
20	D	−0.24	−0.45	−2124	=	−35	NE.	12	
								10	
20	D	−0.24	−0.45	−2100	=	−11	NE.		
21	D	−0.24	−0.46	−2139	=	−48	E.	12	
22	D	−0.62	−0.46	−1933	=	0	SW.	20	
22	D	−0.58	−0.46	−1946	=	+ 4	SW.	20	
23	D	−0.37	−0.44	−2035	=	− 3	SW.	10	
23	D	−0.33	−0.43	−2025	=	+22	SW.	14	
24	D	+0.03	−0.27	−2161	=	− 1	NW.	15	
25	D	+0.01	−0.35	−2207	=	−37	N.	26	
28	D	+0.02	−0.29	−2104	=	+57	N.	20	
28	D	−0.02	−0.32	−2218	=	−67	N.	25	
29	D	−0.08	−0.28	−2110	=	+ 7	N.	11	
June 3	D	−0.16	−0.27	−2110	=	−29	NW.	5	
4	D	−0.28	−0.30	−2046	=	− 7	SW.	10	
7	D	−0.03	−0.10	−2038	=	+60	W.	20	
7	D	−0.04	−0.14	−2113	=	−11	W.	20	
8	D	+0.06	−0.22	−2151	=	+11	NW.	12	
8	D	−0.02	−0.22	−2135	=	− 6	NE.	10	
10	D	−0.21	−0.29	−2079	=	−13	SW.	10	
10	D	−0.27	−0.40	−2022	=	+43	SW.	12	
11	D	−0.25	−0.30	−2081	=	−30	W.	6	
11	D	−0.40	−0.29	−2005	=	−18	SW.	12	
13	D	−0.24	−0.26	−2061	=	−15	NE.	7	
14	D	−0.18	−0.24	−2091	=	−25	NE.	5	
14	D	−0.17	−0.22	−2066	=	0	NE.	12	
15	D	−0.16	−0.22	−2069	=	+ 1	NE.	15	
17	D	−0.22	−0.22	−2025	=	+21	E.	7	
20	D	−0.17	−0.16	−2018	=	+34	E.	5	
22	D	−0.28	−0.18	−2016	=	− 4	SW.	14	
26	D	−0.10	−0.05	−2058	=	− 2	SW.	12	
27	D	−0.14	−0.11	−2064	=	−10	SW.	9	
28	D	−0.16	−0.10	−1989	=	+54	SW.	18	

Observation equations, St. Clair River discharge—Continued.

						v	Wind. Direc-tion.	Wind. Miles per hour.	Lexington minus G. T. R.
1902.									
Aug. 12	D	−0.05 A	+0.32 B	−1995	=	+ 3	NE.	11	1.24
13	D	−0.19	+0.28	−1944	=	− 3	SE.	8	1.24
14	D	−0.17	+0.22	−1974	=	− 4	NE.	6	1.25
15	D	−0.06	+0.27	−2012	=	− 11	N.	6	1.23
16	D	−0.08	+0.21	−2004	=	+ 3	NE.	13	1.17
18	D	−0.24	+0.22	−1932	=	+ 9	SW.	9	1.27
18	D	−0.20	+0.17	−1922	=	+ 44	SW.	11	1.20
19	D	−0.20	+0.19	−1960	=	+ 1	N.	12	1.23
19	D	−0.13	+0.21	−2018	=	− 20	NE.	13	1.22
20	D	−0.19	+0.19	−1960	=	+ 13	SE.	6	1.26
21	D	−0.06	+0.23	−2020	=	− 10	NE.	12	1.22
21	D	−0.02	+0.28	−2015	=	+ 1	NE.	12	1.22
22	D	+0.05	+0.26	−2075	=	− 22	NW.	16	1.22
25	D	−0.26	+0.30	−1940	=	− 33	N.	6	1.27
26	D	−0.27	+0.16	−1926	=	+ 4	W.	7	1.24
26	D	−0.17	+0.18	−1948	=	+ 27	W.	14	
27	D	−0.16	+0.13	−1980	=	+ 16	N.	9	1.24
28	D	−0.22	+0.14	−1967	=	− 3	NE.	14	1.26
Sept. 2	D	−0.20	+0.10	−1974	=	+ 7	N.	9	
3	D	−0.58	+0.10	−1766	=	+ 57	SW.	17	
4	D	+0.20	+0.25	−2135	=	− 21	NW.	20	
4	D	0.00	+0.20	−2096	=	− 54	NW.	22	
5	D	−0.27	+0.03	−1954	=	+ 14	W.	7	
5	D	−0.35	+0.04	−1945	=	− 13	NE.	6	
6	D	−0.94	−0.01	−1707	=	− 9	SW.	15	
6	D	−0.53	+0.03	−1840	=	+ 20	SW.	12	
8	D	−0.63	−0.08	−1840	=	− 5	SW.	12	1.24
8	D	−0.70	−0.09	−1767	=	+ 45	SW.	20	1.29
10	D	−0.40	+0.02	−1848	=	+ 68	SW.	15	
11	D	−0.40	+0.02	−1901	=	+ 15	SW.	12	
12	D	−0.28	−0.02	−1950	=	+ 26	SW.	4	
13	D	−0.41	+0.06	−1870	=	+ 32	W.	15	
15	D	−0.50	+0.04	−1821	=	+ 45	SW.	13	1.30
15	D	−0.55	−0.01	−1779	=	+ 81	SW.	15	1.28
16	D	−0.57	−0.11	−1865	=	+ 18	S.	6	1.27
16	D	−0.52	−0.12	−1798	=	+100	S.	12	
17	D	−0.67	−0.12	−1790	=	+ 37	SE.	7	1.25
17	D	−0.65	−0.12	−1817	=	+ 39	S.	10	1.19
18	D	−0.54	−0.15	−1835	=	+ 61	S.	9	
19	D	−0.28	−0.03	−1948	=	+ 30	N.	12	1.16
20	D	−0.42	−0.03	−1880	=	+ 39	SE.	3	1.28
22	D	−0.51	−0.09	−1878	=	+ 9	SW.	4	1.21
22	D	−0.52	−0.08	−1841	=	+ 52	SW.	4	1.28
23	D	−0.47	−0.08	−1879	=	+ 26	N.	5	1.27
23	D	−0.38	−0.03	−1906	=	+ 26	N.	12	1.23
24	D	−0.45	+0.05	−1908	=	− 15	E.	20	1.22
25	D	−0.69	+0.20	−1792	=	− 33	E.	10	1.17
26	D	−0.55	+0.08	−1826	=	+ 14	S.	6	1.13

The mean of Grand Trunk gauge readings is 579.403.

The mean of Roberts Landing gauge readings is 575.934.

Lexington gauge to be comparable with Sand Beach should have 0.388 subtracted.

Giving each equation a weight of one the following normal equations are obtained:

$$(+240D) \quad -76.00A \quad -16.33B \quad -472994=0$$
$$-76.00D(+46.95A)+18.84B \quad +143355=0$$
$$-16.33D \quad +18.84A(+17.82B)+ \quad 30275=0$$

Solving the normal equations the following values are derived for D, A, and B:

$D=$ 2087.1= 208710 cubic feet.
$A=$ 415.9= 41590 cubic feet.
$B=-$ 226.1=− 22610 cubic feet.

The agreement of B—22610 with the theoretical value —23704 is good.

There is considerable difference in the value of A41590 and the theoretical value 34628.

To obtain the probable errors of the quantities D, A, and B, the weights must be obtained. For this a general solution of the normal equations was made. Putting $-L$, $-M$, and $-N$ in place of the absolute terms the solution gave:

$$D= (0.01026L)+ 0.02232M-0.01418N$$
$$A= 0.02232L + (0.08550M)-0.06996N$$
$$B=- 0.01419L - 0.06996M+(0.11710N)$$

From these the weights are:

$$\text{Weight of } D=\frac{1}{0.01026}=97.4$$

$$\text{Weight of } A=\frac{1}{0.08550}=11.7$$

$$\text{Weight of } B=\frac{1}{0.11710}= 8.5$$

The sum of the squares of the residuals (vv) the number of observation equations m and the number of unknown quantities μ are:

$$(vv)=313440$$
$$m= 240$$
$$\mu= 3$$

The formula for the probable error for an observation of weight one is—

$$\text{Probable error}=0.6745\sqrt{\frac{(vv)}{m-\mu}}$$

This gives the probable error for an observation of weight one or a single observed discharge $\pm 24.5 = \pm 2450$ cubic feet.

Dividing this by the square roots of the weights given above the probable errors of D, A, and B are as follows:

Probable error of $D=\pm 2.5=\pm 250$ cubic feet.
Probable error of $A=\pm 7.2=\pm 720$ cubic feet.
Probable error of $B=\pm 8.4=\pm 840$ cubic feet.

The formula for the discharge is then—

Discharge=208710+41590 (G. T. R.—579.72)—22610 (Rob. Ldg.—576.00) . . (10)

For G. T. R. 579.72 and Roberts Landing 576.00 the discharge is 208710±250. The probable error of the coefficient 41590 for G. T. R. is ±720 and of 22610 for Roberts Landing is ±840.

Residuals for discharge.

The largest residuals, +100 September 16, 1902, and —99 April 29, 1899, correspond to errors of +10000 and —9900 cubic feet per second in the measured discharges.

The residuals show a permanence of minus sign from the beginning of observations, April 29 to July 17, 1899, 28 in number, with only two exceptions where the residuals are small, +9. From July 18 to August 15 the residuals, 15 in number, are plus except in two cases. In 1900 the first 4 residuals are minus June 19 to 22, and plus for the 36 observations following from June 25 to September 14. In 1901 the observations were made from May 14 to June 28, and the signs of residuals are mixed. In the observations of 1902 the signs from September 6 to 23, 20 in number, are plus except one small one, —5.

The permanences in signs of residuals can not be made to disappear by taking an equation for the discharge of a different form from that adopted because the same combination of stages at different times gives the residuals with opposite signs. From June 2 to 14, 1899, with the Grand Trunk Railway gauge 0.3 of a foot below normal and the Roberts Landing gauge 0.2 of a foot above normal, the residuals range from —94 to —40, while for the same stages from August to September 10, 1900, they range from +24 to +50.

The difference between the Sand Beach gauge and Grand Trunk Railway gauge for the 19 observations, April 29 to June 13, 1899, is 0.80 of a foot and the mean residual —72; for the 36 observations, June 29 to September 19, 1900, the difference

of gauges is 0.81 and the mean residual +36. The monthly means of these two gauges do not show any seasonal variation in the differences. The slope of river from Grand Trunk Railway gauge to Lake Huron increases gradually from April to August, as shown by the Light-house gauge for the year 1900. Lake Huron rises from May to July and falls to December. There is a marked tendency for the residuals to be minus in the beginning of the year and plus later on. The signs of residuals do not show any dependence on the differences of Sand Beach and Grand Trunk Railway gauges in 1901 and 1902. The record of self-register at Sand Beach begins in March, 1901; previous to that there are only staff-gauge readings made three times a day. The distance from Sand Beach to St. Clair River is 60 miles.

While it is likely that if the slope from the Grand Trunk Railway gauge to Lake Huron were known and taken into account in deriving the formula for the discharge it would be improved, yet it is not likely that the permanences in signs of residuals would disappear.

The differences between Grand Trunk Railway and Light-house gauges show a marked dependence on the wind, but the residuals do not. A good example of the effect of the wind may be seen in the stages of December 6 and 7, 1899. For December 6, with wind NW. 20 miles an hour, the Light-house gauge was 579.93 and the Grand Trunk Railway gauge was 579.18, a difference of 0.75 of a foot, while on December 7, wind S. 20, the readings were 578.38 and 577.79, a difference of 0.59 of a foot.

The direct effect of wind on discharge in carrying the surface water of river with it is small. In the final result for discharge it is inappreciable, as it blows as often with as against the current. This effect, if perceptible, ought to appear in the vertical velocity curves. In the report for 1900, page 5374, it is shown that the effect is comparatively slight and does not extend to the two-tenths depth point.

The effect of a north wind in heaping up the water at the south end of Lake Huron is felt at once in the increase of velocity at the cross section where the discharge is being measured. Any effect on the residuals from this source could only come from the rise in lake not causing a like rise at the Grand Trunk Railway gauge.

In the course of a single discharge measurement there are usually considerable changes in the Grand Trunk Railway gauge readings. There occurs a rise of two-tenths to three-tenths of a foot from the beginning of a measurement extending over an hour followed by a greater or less fall and then a rise again toward the end of a measurement, or the reverse of this takes place. In the 1902 observations the gauge was much steadier than during the measurements in preceding years. There were large changes during some measurements in 1899, a fall of 0.82 May 1, a rise of 1.05 June 5, a rise of 0.61 June 13, a fall of 0.68 June 14, a rise of 0.79 June 29, a fall of 0.69 July 20, a fall of 0.87 and rise of 0.71 September 7. The rises and falls are phases of constantly recurring waves of different periods. The wave period is in most cases much shorter than the time required in making a discharge measurement. In the 1902 observations it took 4 hours and 37 minutes to make a complete discharge measurement. The result of this is that a measurement usually includes velocities observed over every phase of a wave on some one of the various sections which comprise the cross section of the river. For the most part, therefore, there is no apparent dependence of the residuals on change characteristics in gauge readings.

On days when there was a rising or falling stage during all or nearly all the time of a measurement there is a dependence of the sign of residual on this characteristic. For a rising stage, which corresponds to the front of a wave with steep slope the residual is minus, the observed value of discharge being greater than the computed. The cases approximating half a foot of rise or fall during a measurement are shown below.

Date.	Rise.	Residual.	Date.	Fall.	Residual.
1899.	*Feet.*		1899.	*Feet.*	
June 3	0.50	−97	June 14	0.68	+ 9
June 12	.40	−39	July 20	.69	+29
June 13	.61	−38	August 24	.45	+22
July 29	.42	− 9	November 29	.45	+28
November 17	.41	−48			
November 21	.37	−13	1900.		
November 28	.40	− 2	June 30	.36	+14
			September 17	.60	+50
1900.			December 8	.56	+ 4
June 29	.79	+36	December 21	.38	+17
December 22	.45	−17			

The permanences in the signs of the residuals are probably for the most part due to some source of constant error in the observations, and this is most likely to be in the unavoidable errors in rating the meters, or to unknown changes in the coefficients after rating. That these changes in the meters are considerable may be seen from report of 1900, page 5369, where for meter No. 1B the same number of turns that gave a velocity of 3.20 feet per second in October gave 3.09 in November.

Residuals gauges Dry Dock and Kendalls.

The heights by the section gauge Dry Dock computed by (9), $x_2=0.769H+0.226h$ added to 578.795 Table I compared with the observed values give computed minus observed 1899 −0.04, 1900 −0.02, 1901 −0.01, 1902 −0.01

The gauge at the mouth of Black River, Kendalls computed by (9), $x_1=0.862H+0.132h$ added to 579.170 Table I gives computed minus observed 1901 −0.03, 1902 −0.03.

The residuals are small and mostly minus. The largest, December 6, 1899, is −0.14. There is one of −0.09 and a few as large as −0.07 and −0.05.

The formula for the discharge is derived on the ussumption that no water comes into the St. Clair River except from Lake Huron. The Black River, which enters at Port Huron, drains an area of 800 square miles. Taking the average discharge as one-fourth of a rainfall of 32 inches in a year over the area, the discharge would be 480 cubic feet per second. The Black River comes in above the Dry Dock section, so the discharge measurements include it. The Black River comes in below the Grand Trunk Railway gauge and its readings are not affected.

Other streams coming into the St. Clair River between the Dry Dock section and Roberts Landing gauge, the Pine River, and Belle River principally, drain an area of 400 square miles from which the discharge would be on the average 240 cubic feet per second.

On the eastern side of the river, in Canada, the streams entering the St. Clair River between Sarnia and Roberts Landing drain 70 square miles, which add about 40 cubic feet per second to the river.

The total of these is 760 cubic feet per second coming into the river between Lake Huron and Lake St. Clair on the average for the year.

The monthly means of readings of Fort Gratiot Light-house and Grand Trunk Railway gauges and the differences are shown in Table II below for December, 1899, and April to August, 1900. The differences between these gauges during the time of measurement for 62 of the discharge observations from October 10, 1899, to November 30, 1900, are shown with the observations equations. The mean of the differences is 0.68 of a foot. The corresponding mean of the Fort Gratiot Light-house gauge is 579.95. The mean of the Roberts Landing gauge for the same discharge measurements is 575.92.

TABLE II.—*Monthly mean water levels—Self-registering gauges.*

Date.	Fort Gratiot Light-house gauge.	Grand Trunk Railway gauge.	Fort Gratiot minus G. T. R.	Roberts Landing gauge.
1899.				
November	579.68	579.03	0.65	575.56
December	579.46	578.83	.63	575.50
1900.				
April	579.37	578.78	.59	575.83
May	579.67	578.99	.68	575.63
June	579.77	579.14	.63	575.82
July	580.02	579.36	.66	576.00
August	580.12	579.43	.69	576.09

Table III gives the differences of gauges on some particular days.

TABLE III.—*Means of water levels.*

Date.	Time of readings.	Number of observations.	Fort Gratiot lighthouse gauge.	G. T. R. gauge.	Difference.
1899.					
May 16	10 minutes	64	580.10	579.14	0.96
17	do	64	580.07	579.06	1.01
18	do	64	580.00	579.21	0.79
June 9	do	64	580.57	579.62	.95
26	do	64	580.36	579.70	.66
27	do	64	580.32	579.68	.64
28	do	64	580.48	579.83	.65
29	do	64	580.73	579.79	.94
30	do	64	580.72	579.77	.95
July 1	do	64	580.44	579.58	.86
Dec. 7	9.30 to 10.11	20	578.38	577.79	.59
7	10.20 to 10.50	19	578.53	577.94	.59
8	8.20 to 8.51	20	579.68	579.02	.66
8	9.03 to 9.40	20	579.53	578.92	.61
8	9.53 to 10.32	20	579.50	578.85	.65
8	10.55 to 11.33	20	579.50	578.82	.68
8	12.47 to 1.35	20	579.68	578.91	.77
8	2.06 to 2.39	20	579.86	579.11	.75
8	2.42 to 3.28	20	579.77	579.12	.65
9	8.32 to 8.45	20	579.14	578.52	.62
9	9.29 to 10.04	20	579.05	578.47	.58

The monthly means of water levels by the Sand Beach and Grand Trunk Railway gauges and the differences are shown in Table IV; also the means and differences for Roberts Landing and St. Clair Flats Canal gauges. Previous to March, 1901, the Sand Beach levels are from staff-gauge readings.

TABLE IV.—*Monthly mean water levels.*

Date.	Sand Beach gauge.	G. T. R. gauge.	Sand Beach minus G. T. R.	Roberts Landing gauge.	St. Clair Flats Canal gauge.	Roberts Landing minus St. Clair.
1899.						
April	579.42	578.77	0.65			
May	579.95	579.14	.81			
June	580.35	579.58	.77			
July	580.64	579.86	.78	576.28	575.45	0.83
August	580.55	579.80	.75	576.26	575.39	.87
September	580.35	579.61	.74	576.08	575.08	1.00
October	579.94	579.16	.78	575.72	574.78	0.94
November	579.80	579.03	.77	575.56	574.65	.91
December	579.61	578.83	.78	575.50	574.59	.91
1900.						
April	579.53	578.78	.75	575.83	574.81	1.02
May	579.69	578.99	.70	575.63	574.92	0.71
June	579.86	579.14	.72	575.82	575.09	.73
July	580.11	579.36	.75	576.00	575.17	.83
August	580.19	579.43	.76	576.09	575.22	.87
September	580.28	579.41	.87	576.04	575.10	94
October	580.22	(579.33)	.89	575.86	574.94	.92
November	580.22	579.31	.91	575.76	574.82	.94
December	580.02	579.08	.94	575.62	574.67	.95
1901.						
April	580.04	579.58	.46	576.06	[a] 573.11	2.95
May	580.31	579.55	.76	575.74	[a] 574.21	1.53
June	580.40	579.53	.87	575.80	574.97	0.83
July	580.55	579.73	.82	576.07	575.18	.89
August	580.60	579.82	.78	576.14	575.18	.96
September	580.37	579.58	.79	576.03	575.16	.87
October	580.15	579.35	.80	575.79	574.84	.95
November	579.92	(579.14)	.78	575.55	574.55	1.00
December	579.61	578.88	.73	575.71	574.58	1.13
1902.						
April	579.40	578.67	.73	575.25	574.39	0.86
May	579.65	578.88	.77	575.42	574.64	.78
June	579.97	579.20	.77	575.77	575.01	.76
July	580.25	579.51	.74	576.33	575.64	.69
August	580.33	579.58	.75	576.26	575.50	.76
September	580.01	579.29	.72	576.03	575.22	.81
October	579.76	579.10	.66	575.88	575.12	.76
November	579.63	578.91	.72	575.64	574.83	.81
December	579.42	578.79	.63	575.74	574.93	.81

[a] Ice jam.

The mean differences for four years between Sand Beach and Grand Trunk Railway gauges and Roberts Landing and St. Clair Flats Canal are shown in Table V.

TABLE V.—*Monthly mean differences of water level, four years. 1899–1902.*

Date.	Sand Beach minus G. T. R.	Roberts Landing minus St. Clair Flats Canal.	Date.	Sand Beach minus G. T. R.	Roberts Landing minus St. Clair Flats Canal.
April			September	0.78	0.90
May	0.76	0.74	October	.78	.89
June	.78	.77	November	.79	.91
July	.77	.81	December	.77	.95
August	.76	.86			

The gauge heights depend on bench mark "Fort Gratiot," 589.90 above mean tide at New York. (1877.)

The mean difference between Sand Beach and Grand Trunk Railway gauges from May to December is 0.77 of a foot.

The difference between Roberts Landing and St. Clair Flats Canal increases regularly from 0.74 in May to 0.95 in December, mean 0.85.

A rise of Lake St. Clair, causing a rise at Roberts Landing, would cause backwater and a rise at Grand Trunk Railway gauge and later at Lake Huron. The rise at Grand Trunk Railway gauge would occur quickly, as it would take but a short time to fill up the river to the new level. To fill up Lake Huron to the new level would, however, require a long time, some years. The difference between Grand Trunk Railway gauge and Lake Huron must then depend on the phase in which a rise of this kind happens to be and therefore on time. For a rapid fall in Lake Huron due to a small supply of water and great evaporation the same thing would occur, a variable difference depending on the time.

It is not possible, therefore, to assign accurately the fall from Lake Huron to the Grand Trunk Railway gauge. This can only be done by observation.

To apply the formula for discharge to the back records of the levels of the lakes the best that can be done is to subtract 0.77 of a foot from Sand Beach to derive Grand Trunk Railway gauge height and add to the St. Clair Flats Canal gauge the quantities given in Table V, depending on the month, to obtain the Roberts Landing gauge height, or apply the mean 0.85 and then apply the formula.

For the 53 discharge measurements from May 14, 1901, to August 28, 1902, the mean of the Sand Beach gauge for the same time is 580.35 and the Grand Trunk Railway gauge 0.81 of a foot less.

A rise in Lake St. Clair due to a rise in Lake Erie caused by an increased rainfall over the drainage area or a diminished evaporation or an obstruction at the outlet, would in the course of time produce a rise in Lake Huron, the supply of water to the lake and the evaporation remaining uniform in the meantime. A rise in Lake St. Clair would cause a decrease in the discharge of St. Clair River and a gradual rise in Lake Huron until, with the increased cross section at entrance to river and modified slope, the discharge increased to what it was formerly.

To find what the rise in Lake Huron would be for a rise in Lake St. Clair, it will be derived as follows: First, the rise at the Grand Trunk Railway gauge caused by a rise in Lake St. Clair, and, second, the rise in Lake Huron due to a rise at the Grand Trunk Railway gauge.

A rise of 1 foot in Lake St. Clair will produce a rise of 1 foot at Roberts Landing. In equation (10) substituting for Roberts Landing 577.00 and for G. T. R. $579.72+x$, x being the unknown rise at G. T. R. for a rise of 1 foot at Roberts Landing, the equation becomes—

$$\text{Discharge}=208710+41590\ (x)-22610$$

The discharge when the rise is completed will be the same as at first, or 208,710. The equation then gives—

$$x=\frac{22610}{41590}=0.543$$

The cross section of river at Grand Trunk Railway gauge is 40,000 square feet, the width 1,132 feet, and the depth 35.3 feet. (Report for 1900, p. 5363.)

For a discharge of 208,710 cubic feet per second the velocity v is—

$$v=5.218 \text{ feet per second.}$$

The head h required to produce this velocity from the formula $v=\sqrt{2gh}$ is—

$$h=\frac{v^2}{2g}=0.423 \text{ foot.}$$

For a rise of 0.543 foot at Grand Trunk Railway gauge the cross section becomes 40,615 square feet.

The velocity v_1 for the same discharge 208,710 cubic feet is—

$$v_1=5.139 \text{ feet per second.}$$

The head h' required to produce this velocity is—

$$h'=\frac{v_1^2}{2g}=0.411 \text{ foot.}$$

Taking the difference between the level of Lake Huron and the Grand Trunk Railway gauge as 0.755 foot for the reading 579.72 at the latter, the friction head for the velocity v is $0.755-0.423=0.332$. Taking the friction heads for the two cases proportional to the squares of the two velocities, the friction head for v_1 is found to be 0.324 foot. This added to the velocity head 0.411 for v_1 gives the difference of level between Lake Huron and Grand Trunk Railway gauge 0.735 foot for a rise of 0.543 at the Grand Trunk Railway gauge. This as compared with 0.755, which it was before the rise, is a decrease of 0.020 foot. The rise of Lake Huron will then be $0.543-0.020=0.523$.

The rise of Lake Huron, therefore, corresponding to a rise of 1 foot in Lake St. Clair due to a rise of Lake Erie would be 0.52 foot. It would require a long time to produce this rise, many years in fact, on account of the great area of Lakes Huron-Michigan, which is 45,600 square miles.

The rise in Lake Huron for a rise of 1 foot in Lake St. Clair has also been derived theoretically, taking into account the varying width, depth, and slope of the river over different stretches.

The dimensions of various stretches of the river are given in the first part of this discussion (Table I.)

With a discharge of 208,710 cubic feet per second, for Grand Trunk Railway gauge 579.72 and Roberts Landing 576.00, with an average width of 2,430 feet and depth of 28 feet, the velocity v is—

$$v=3.067 \text{ feet per second.}$$

From the Chezy formula, $v=c\sqrt{RS}$. With this value of v the value of c is—

$$c=0.3005.$$

For a rise of 1 foot at Roberts Landing let the corresponding rise at Grand Trunk Railway gauge be denoted by x. Assuming c to be the same after the rise as before, the velocity after the rise will be—

$$v_1=0.3005\sqrt{(28.5+\frac{1}{2}x)\ (2.72+x)}.$$

The depth after the rise of 1.0 foot at Roberts Landing and x at Grand Trunk Railway gauge is $(28.5+\frac{1}{2}x)$. The original velocity multiplied by the original cross section will be the discharge which must be equal to the new velocity multiplied by the new cross section, or—

$$(3.067)\ (2430)\ (28)=0.3005\sqrt{(28.5+\frac{1}{2}x)\ (2.72+x)}\ (2430)\ (28.5+\frac{1}{2}x).$$

This reduced to a form convenient for computation becomes—

$$(x+57)^3\ (x+2.72)=653300.$$

Equations similar to this were formed for the eight stretches of river previously described.

The rise at Grand Trunk Railway gauge for a rise of 1.0 at Roberts Landing was found in this way to be 0.62 foot. With the diminution of 0.02 foot in the head to Lake Huron previously found, the rise in Lake Huron is 0.60 foot. The rise by the observation formula was found to be 0.52 foot.

SUMMARY.

The formula for discharge of St. Clair River from observations of 1899, 1900, 1901, and 1902 is—

$$\text{Discharge}=208710+41590\ (\text{G. T. R.}\ -579.72)\ -22610\ (\text{R. L.}\ -576.00)$$

G. T. R. is the reading of Grand Trunk Railway gauge between 578.4 and 580.1.
R. L. is the reading of Roberts Landing gauge between 575.3 and 576.4.
The approximate formula for discharge based on observations of 1899, 1900, and 1901 (Report, 1902, p. 2821) is—

$$Q=198200+37500\ (\text{G. T. R.}-579.4)\ -18000\ (\text{St. Clair Flats}\ -575)$$

Adding 0.9 to 575.00 to reduce to Roberts Landing, the formula gives for G. T. R. 579.72 and Roberts Landing 576.00:

$$Q=208200$$

The corresponding discharge by first formula is—

$$\text{Discharge}=208710$$

To apply the formula to back records of Lake Huron and Lake St. Clair, subtract 0.77 from Sand Beach gauge readings and add 0.74 to 0.95 to St. Clair Flats Canal gauge readings depending on the month or the mean 0.85 regardless of time.
The backwater for a rise of 1 foot in Lake St. Clair, due to a rise of Lake Erie, is 0.54 foot at Grand Trunk Railway gauge and 0.52 at Lake Huron, as derived from formula based on observations of 1899 to 1902.
The backwater for a rise of 1 foot in Lake St. Clair derived theoretically by dividing the river into 9 stretches and considering the varying width, depth, and slope over each is 0.62 foot at Grand Trunk Railway gauge and 0.60 foot at Lake Huron.
The formula and backwater apply for a free river when there is no ice effect.
Very respectfully,

THOMAS RUSSELL, *Assistant Engineer.*

Maj. W. L. FISK,
Corps of Engineers, U. S. Army,

F F F 2.

ENGINEER OFFICE, U. S. ARMY,
Detroit, Mich., July 20, 1903.

GENERAL: I have the honor to submit with my annual report for the fiscal year ending June 30, 1903, a special report on the outflow, rainfall, and evaporation in the valley of the Northern and Northwestern Lakes.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

U. S. ENGINEER OFFICE, JONES BUILDING,
Detroit, Mich., June 25, 1903.

MAJOR: I have the honor to submit the following discussion of the outflow, rainfall, and evaporation in the valley of the Great Lakes:

DRAINAGE BASINS.

The outlines and areas of the drainage basins of the several lakes were first determined. Plate I is a map of these basins. This map

was compiled from the best topographical maps available. It was also compared with a similar map prepared by the Deep Waterway Commission. The watershed or boundary of the basin was determined by a study of the sources of the streams. In the United States the land survey maps show these with considerable accuracy. It is likely that the township in which a stream has its rise is in almost all cases correctly given, and the location of the source is known within less than 6 miles. In a portion of Canada the maps have equal accuracy.

In order to make an approximate estimate of the error in the determination of the area of the drainage basin, it might reasonably be assumed that the best located part of the boundary was never more than 6 miles in error, and this not oftener than once in a hundred miles. This error would sometimes be inside the basin and sometimes outside as a compensating error. Since there is about 2,500 miles of the developed boundary line known with this accuracy, there might be about 500 miles uncompensated, which would make a possible error of about 1,500 square miles. In the northwestern part there is about 900 miles of the boundary where the maps are less accurate, and it might be reasonably assumed that the location is never more than 20 miles in error, and this not oftener than once in a hundred miles. Then the uncompensated possible error in this part of the boundary would be about 3,000 square miles, and the total possible error with this assumption would be about 4,500 square miles, or about $1\frac{1}{2}$ per cent of the total area of the basins. It is therefore probable that the areas of the several basins are correctly determined within less than 2 per cent.

After the boundary line was drawn on the map the area included by it was determined as follows:

Quadrilaterals of one degree or less in extent, bounded by meridians and parallels, were selected so as to completely cover the basin; this gave a polygon, the sides of which were meridians and parallels. The total area of this polygon was determined accurately from geodetic tables of areas. Those small parts of the polygon which extended outside of the boundaries of the basin were measured on the map with a planimeter and subtracted, the remainder being the area of the basin. This work was done with care and checked, and it is believed that the areas of the lakes and basins as herewith given on Plate I are as accurate as extant maps will permit.

In determining the area of the lakes their connecting waters were included; the lines of division between the lakes were chosen at the points where the discharge measurements were made, viz, Sault Ste. Marie, Port Huron, Buffalo, and Ogdensburg. For this determination the lake survey maps were used and the same method followed as for the entire basin. It is seen from this map that the northeast watershed approximates a straight line for a distance of more than 800 miles—that is, a straight line could be drawn for that distance so that at no point would its distance from the watershed be more than 30 miles. It will also be noticed that at certain points the shores of Lakes Superior, Michigan, and Erie approach to within less than 10 miles of the boundaries of their basins.

LAKE ELEVATIONS.

The changes in the elevation of the surfaces of the Great Lakes, and consequently of the rivers connecting them, are small, the mean annual change being less than 2 feet, while the extreme range in


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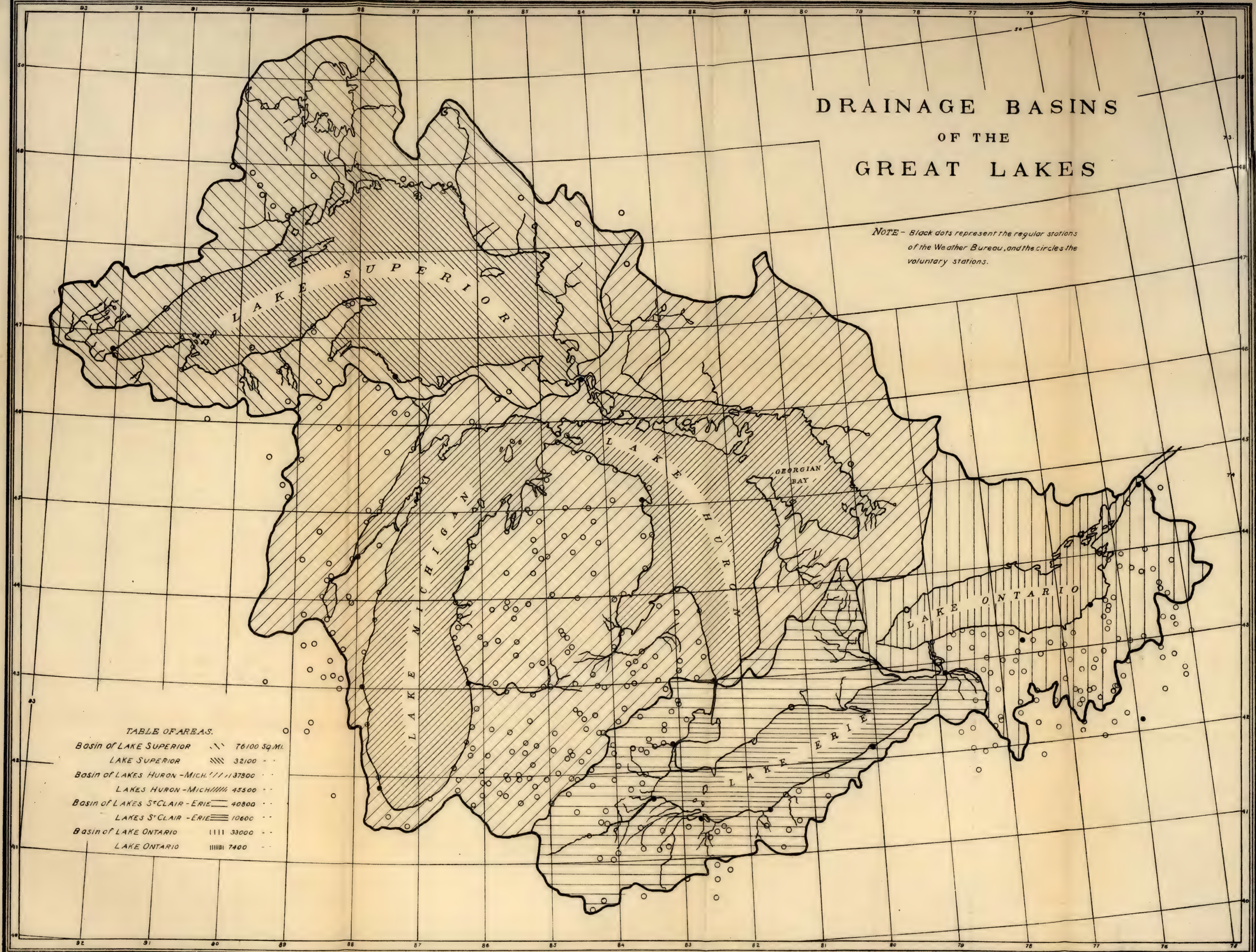

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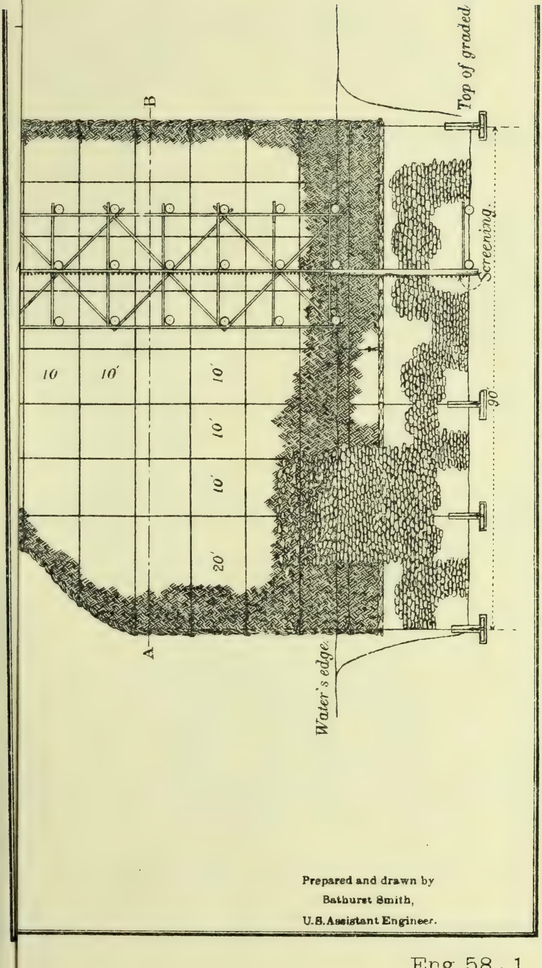
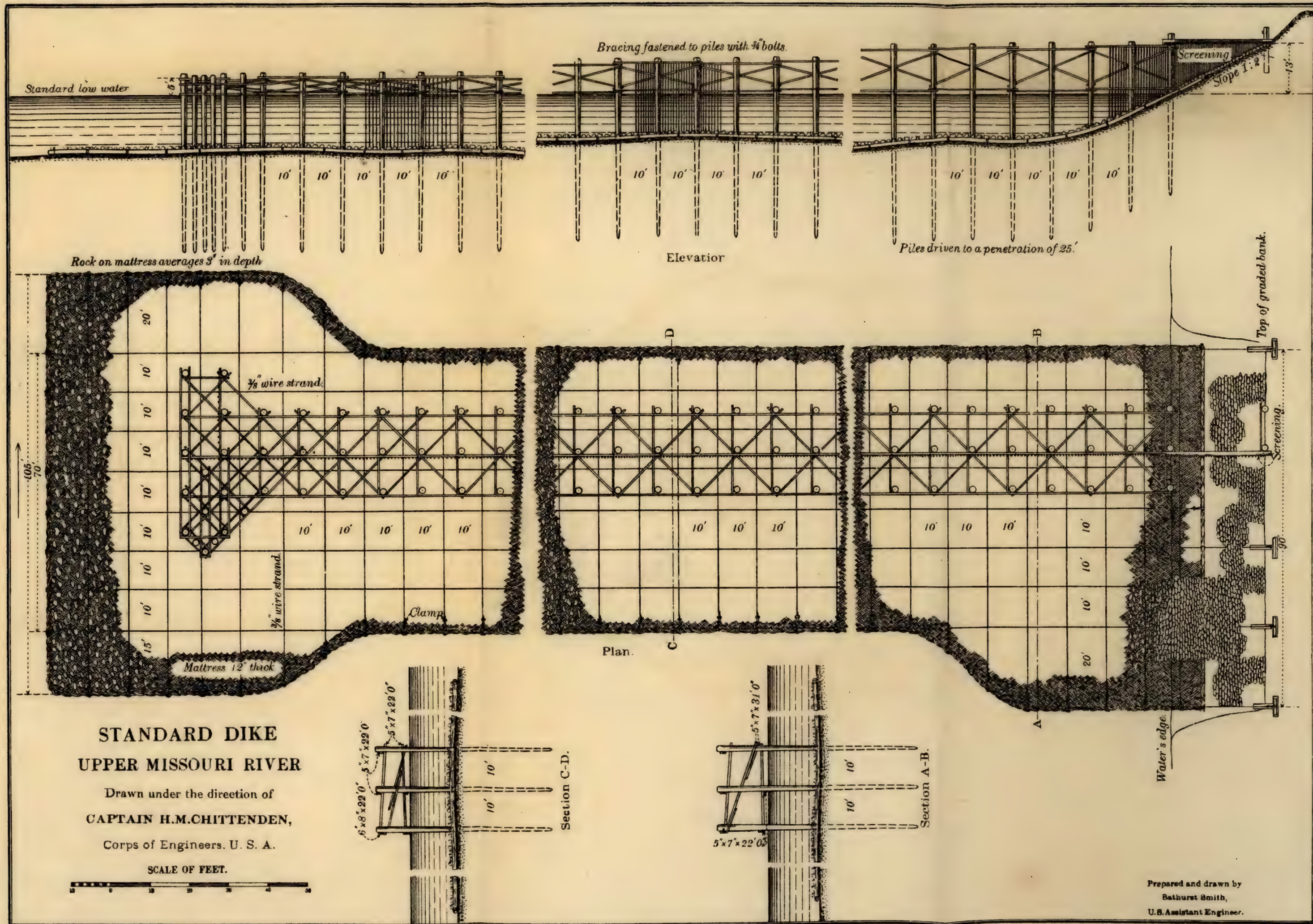


Prepared and drawn by
Bathurst Smith,
U.S. Assistant Engineer.



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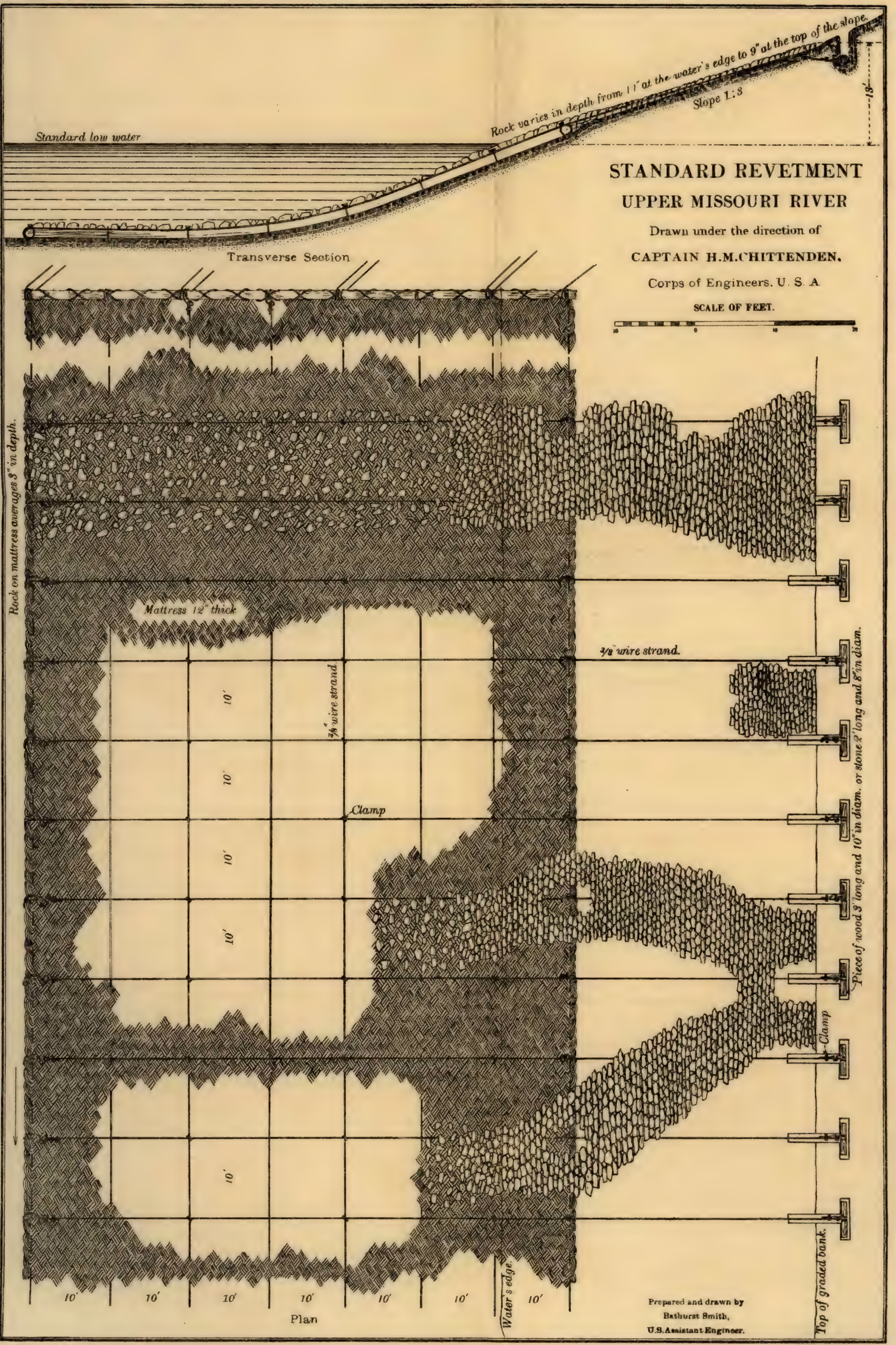

STANDARD REVETMENT
UPPER MISSOURI RIVER
Drawn under the direction of
CAPTAIN H.M.CHITTENDEN,
Corps of Engineers. U. S. A.
SCALE OF FEET.
Standard low water
Rock varies in depth from 11" at the water's edge to 9" at the top of the slope.
Slope 1:3
13'
Transverse Section
Rock on mattress averages 8" in depth.
Mattress 12" thick
3/8" wire strand.
3/8" wire strand.
10'
Clamp
Piece of wood 3' long and 10" in diam. or stone 2' long and 8" in diam.
Clamp
Top of graded bank.
Water's edge.
Plan
Prepared and drawn by
Bathurst Smith,
U.S. Assistant Engineer.
ANDREW B GRAHAM PHOTO LITHO WASHINGTON DC

monthly means for the last forty-two years is less than 5½ feet. The records of the elevations of all the lakes, except St. Clair, since 1860 are continuous and reasonably trustworthy. They have been published from year to year in the Report of the Chief of Engineers, from which they have been collected and are herewith given in Tables I to V.

The elevations of Lake St. Clair, herewith given in Table III, are not all directly observed; before 1872 no observations were made at Lake St. Clair; all the elevations given in the tables before that date and a few after it have been computed from the observed elevations of Lakes Huron and Erie. The formula used for such computations is taken from page 5397 of the Report of the Chief of Engineers for 1900, and is as follows:

St. Clair Flats=574.06+407 (4–580) +452 (E–570) where H=elevation of Lake Huron and E=elevation of Lake Erie, as herewith given in Tables II and IV.

For Lake St. Clair the elevation for the summer months only have been used, as the elevations during the winter months are often seriously disturbed by the ice, as discussed on page 2822 of Report of Chief of Engineers for 1902.

OUTFLOW AND DISCHARGE FORMULÆ.

The outflow from the lakes has been measured at different times by the United States lake survey; the measurements since 1896 have been made with modern and improved appliances; the results have been very accordant. The discharge formulas derived from this later work have been used in this discussion. It is found that within the small observed range of the surface elevation the discharge is so near a linear function of the surface elevation that one can be derived from the other with considerable accuracy; therefore, the discharge can be determined whenever the surface elevation is known. This has been done for the years 1860 to 1902, and the results are herewith given in Tables VI to IX, and also shown graphically in Plate II.

The discharge from Lake Superior was measured at Sault Ste. Marie from 1896 to 1899, and discharge formulæ were deduced therefrom in 1900.

Between 1887 and 1892 the outlet of Lake Superior was somewhat contracted by the building of the International Bridge piers at Sault Ste. Marie, and also by the closing of some of the small streams on both sides of the river. These changes make the discharge formulæ different for different periods, as follows:

Before 1888, discharge in s–f=46,047+19,429 x (elev.—600).

From 1888 to 1895, inclusive, discharge in s–f=39,798+17,656 x (elev.—600).

From 1896 to 1898, inclusive, discharge in s–f=43,466+17,656 x (elev.—600).

After 1898, discharge in s–f=49,235+17,656 x (elev.—600).

In these formulæ "elevation" means the elevation of lake surface as herewith given in Table I.

The data and methods used in determining such formulæ, not having as yet been printed or otherwise published, are herewith attached and marked "Appendix A."

The outflow from Lakes Michigan and Huron was measured at Port Huron from 1898 to 1900. The results are given on pages 2819 et seq. of the Report of the Chief of Engineers for 1902. It was found that the

discharge of St. Clair River was not exactly a linear function of the surface elevation of Lake Huron, but was modified by two causes—first, the surface elevation of Lake St. Clair, and, second, ice during the winter season.

The formula for the discharge of St. Clair River during the summer months includes the surface elevation of both Lakes Huron and St. Clair. It is given on page 2821 of the Report of the Chief of Engineers for 1902, as follows:

Discharge in s–f=190,700+37,500 (H−580 ft.)−18,000 (St. Clair−575 ft.), in which H=the surface elevation of Lake Huron as herewith given in Table II, and St. Clair=the surface elevation of Lake St. Clair as herewith given in Table III. This formula is used in computing the discharge of the St. Clair River for the summer months—June to November, inclusive. For the winter months—December to April, inclusive—this formula is not applicable because of the ice effects.

A formula for the discharge of St. Clair River when the elevation of Lake Huron is alone considered is given on page 5362 of the Report of the Chief of Engineers for 1900, as follows:

Discharge in s–f=194,900+19,060 x (H−580 ft.), H being the elevation of Lake Huron as given in Table II.

During the winters of 1900, 1901, and 1902 the ice effects were measured. The results are given on page 2837 of the Report of the Chief of Engineers for 1902, and show that the discharge from Lake Huron as computed from the preceding formula was diminished by ice, as follows:

	Second-feet.
December	8,600
January	41,750
February	60,833
March	55,700
April	39,550
May	11,000

Since these three years' observations are all that is known of ice effects it is assumed that they show the average effect of ice. Therefore the discharge for the winter months was first computed from the preceding formula and then each month reduced by the quantities in the above table. This determination of the winter discharge of St. Clair River has the least data and is the most involved and uncertain of any of the discharge determinations. The ice effects are certainly very erratic, and the assumption that the mean of the three observed years is the mean of the forty-three years considered may be somewhat in error.

The outflow from Lake Erie was measured at International Bridge, Niagara River, from 1898 to 1900. The results are given in the Report of the Chief of Engineers for 1900, pages 5326 et seq. The formula for the discharge of Niagara River derived from these results is as follows:

Discharge in s–f=158,500+22,462 (C−570 ft.).

C is the elevation of Lake Erie as herewith given in Table IV.

This formula may require two small corrections: First, the discharge should be increased by the flow through the Welland and Erie canals. The flow through the Welland Canal is estimated by the department of railways and canals of Canada as 1,100 s–f. The flow through the Erie Canal is estimated by the New York engineer for water supply as 1,200 s–f, making a total of 2,300 s–f. The second correction is due to a difference between the zeros of the gauges at Cleveland and Buffalo. This difference has been observed and determined for calm

weather, when it amounts to about 8,500 s–f. For use in this connection the mean for both calm and windy weather should be known; therefore, on account of the remaining uncertainties in these two corrections, neither of them has been applied. The two corrections are in opposite directions and tend to eliminate each other.

The outflow from Lake Ontario was measured from 1900 to 1902. The resulting formula for the discharge of St. Lawrence River is given on page 2793 of the Report of the Chief of Engineers for 1902, and is as follows:

Discharge in s–f=946833+25761 (0−240 ft.),

in which 0 is the elevation of Lake Ontario at Oswego, as herewith given in Table IX.

It was found that for Lake Ontario there was a small correction, due to ice effects, for the winter months. These corrections are given on page 2809 of the Report of Chief of Engineers for 1902, and are as follows:

Percentage of loss on account of ice:	Per cent.
January	6.2
February	9
March	5.3
April	1.2

These percentages have been computed and subtracted from the discharge, as given by the preceding formula.

In the preceding formula the elevation of lake surface above sea level is expressed in feet, and "s–f" means cubic feet per second.

Discharge measurements are still continued by the lake survey, so that it is probable that the preceding formula will in time be slightly modified, so as to be a little more exact, but no large change is expected or possible.

By means of the preceding formula the discharge tables herewith given (VI to IX) have been derived from the tables of surface elevation herewith given (I to V).

RAINFALL.

The rainfall (which includes snowfall) has been compiled from the records of the United States Weather Bureau and the Canadian meteorological service. The period chosen is the sixteen years from 1882 to 1898. The years before 1882 were not used, because the number of stations where rainfall records were kept were few in number; the four years since 1898 could now be added, and thus increase the value of the result. The stations at which observations were made are shown on Plate I herewith. The Weather Bureau stations are indicated by special marks; the other stations are volunteer stations. At many of these observations were made for only a part of the time. It will be seen that the stations are quite unsymmetrically placed in the basin, most of them being in the southern part. This is the most serious defect in the rainfall data. Since the rainfall diminishes both to the north and to the west, it is evident that the direct mean of the rainfall as observed at these stations would be greater than the mean rainfall of the whole basin. To avoid this source of error as far as possible two methods of reduction were employed. The first was to prepare a map for each month on which the stations used during that month were plotted in their proper geographical positions; the inches of rainfall at each station were written in figures, then curves of equal rainfall were drawn among

the plotted points as contours are drawn. These curves show the regions of equal rainfall; the irregular areas bounded by these curves were then measured with a planimeter and each one multiplied by its rainfall, and a mean of all taken, which was assumed to be the mean rainfall in the basin for that month. This method was applied from 1883 to 1893; it required a great amount of work, and was finally changed to the second method, which was shorter and perhaps equally accurate, as follows:

The Weather Bureau has determined the lines of equal rainfall from all available data and published the results in the form of a map (Plate VII of report for 1897); from this map the rate of change in rainfall due to the change in latitude and longitude was determined for each basin. The mean latitude and longitude of the basins was also found; then the rainfall at each station was corrected by its distance in latitude and longitude from the center of the basin.

The results for the several basins are herewith given in Tables X to XIII, and are as follows:

The mean annual rainfall in—	Inches.
Lake Superior basin	=26.27
Lakes Huron and Michigan basins	=32.12
St. Clair and Erie basins	=34.08
Ontario basin	=36.87

The rainfall records are kept in inches, while the unit of discharge is cubic feet per second, or s–f. In order to compare them with each other it is necessary to express both quantities in the same unit; for this purpose the following table is prepared, which shows the equivalent in s–f of the rainfall in the several basins:

Annual rainfall—	s–f.
Superior basin	=147,164
Huron and Michigan	=325,857
St. Clair and Erie	=102,308
Ontario	= 89,557

EVAPORATION.

It is assumed that if the mean annual discharge or outflow from a basin be subtracted from the mean annual rainfall into the basin the remainder will be the mean annual evaporation. For the basin of Lake Superior the mean annual rainfall from the preceding table is 147,164 s–f. The mean annual discharge for sixteen years (1882–1898) from Table VI herewith is 69,954 s–f; the difference is 77,210 s–f=13.78 inches. There is a small correction to apply to this quantity, due to the fact that Lake Superior was 1.31 inches higher at the end of the period considered than at the beginning; this makes a correction of −0.03 inch, and the evaporation for the Lake Superior basin is 13.75 inches.

For the Huron and Michigan basins the mean annual rainfall from the preceding table is 325,857 s–f. The inflow from St. Marys River from Table VI herewith is 69,954 s–f, making the total inflow 395,811 s–f. The discharge or outflow from Table VII herewith is 191,980 s–f. The difference between the inflow and outflow is, then, 203,831 s–f=20.29 inches.

There is a correction to apply to this quantity, due to the fact that Lakes Huron and Michigan were 22.8 inches lower at the end of the period considered (1882 to 1898) than at the beginning; this makes a correction of +0.47 inch, and the evaporation of the Huron and Michigan basin is 20.56 inches.

For the St. Clair and Erie basin the mean annual rainfall from the preceding table is 102,308 s–f. The inflow from St. Clair River from Table VII herewith is 191,980 s–f, making the total inflow 294,288 s–f. The discharge or outflow from Table VIII herewith is 216,468 s–f. The difference between the inflow and outflow is, then, 77,820 s–f=25.90 inches. There is a correction to apply to this quantity, due to the fact that Lake Erie was 12.30 inches lower at the end of the period than at the beginning; this makes a correction of +0.20 inch, and the evaporation of the St. Clair and Erie basin is 26.10 inches.

For the Ontario basin the mean annual rainfall from the preceding table is 89,557 s–f. The inflow from Niagara River is 216,468 s–f, making the total inflow 306,025 s–f.

The discharge or outflow through the St. Lawrence River from Table IX herewith is 248,518 s–f. The difference between the inflow and outflow is, then, 57,507 s–f=23.67 inches. There is a correction to apply to this quantity, due to the fact that Lake Ontario was 10.56 inches lower at the end of the period than at the beginning; this makes a correction of +0.15 inch, and the evaporation of the Ontario basin is 23.82 inches.

WEATHER BUREAU RECORDS.

Temperature, humidity, and wind, together with rainfall, are the four elements which very largely control evaporation. These have accordingly been compiled from the Weather Bureau records. On account of the unsymmetrical geographical distribution of the stations in the basins, a direct mean of the observations would not give a correct mean for the basin. For use and further reference in connection with this report and discussion, the Weather Bureau observations have therefore been reduced in the same manner as previously described for rainfall, and, as so reduced, are given in Tables X to XXV herewith.

GENERAL RESULT.

The results for each basin are herewith summarized, as follows:

Superior basin.

Area of drainage basin	square miles	76,100
Area of Lake Superior	do	32,100
Discharge St. Marys River (mean 1882–1898)	s–f	69,954
Discharge St. Marys River (mean 1860–1903)	do	77,345
Annual rainfall (mean 1882–1898)	inches	26.27
Annual evaporation (mean 1882–1898)	do	13.75
Temperature (mean 1882–1898)		35°.95 F.
Wind, velocity per hour (mean 1882–1898)	miles	9.7
Humidity, percentage of saturation (mean 1882–1898)	per cent	76.5

Huron and Michigan basins.

Area of drainage basin	square miles	137,800
Area of Lakes Huron and Michigan	do	45,500
Discharge St. Clair River (mean 1882–1898)	s–f	191,980
Discharge St. Clair River (mean 1860–1902)	do	197,820
Annual rainfall (mean 1882–1898)	inches	32.21
Annual evaporation (mean 1882–1898)	do	20.56
Temperature (mean 1882–1898)		42°.08 F.
Wind, velocity per hour (mean 1882–1898)	miles	10.3
Humidity, percentage of saturation (mean 1882–1898)	per cent	76.5

St. Clair and Erie basins.

Area of drainage basin	square miles	40,800
Area of Lakes St. Clair and Erie	do	10,600
Discharge Niagara River (mean 1882–1898)	s-f	207,468
Discharge Niagara River (mean 1860–1902)	do	219,843
Annual rainfall (mean 1882–1898)	inches	102.308
Annual evaporation (mean 1882–1898)	do	26.10
Temperature (mean 1882–1898)		48°.01 F.
Wind, velocity per hour (mean 1882–1898)	miles	10.4
Humidity, percentage of saturation (mean 1882–1898)	per cent	73.6

Ontario Basin.

Area of drainage basin	square miles	33,000
Area of Lake Ontario	do	7,400
Discharge of St. Lawrence River (mean 1882–1898)	s-f	248,518
Discharge of St. Lawrence River (mean 1860–1902)	do	251,930
Annual rainfall (mean 1882–1898)	inches	36.87
Annual evaporation (mean 1882–1898)	do	23.82
Temperature (mean 1882–1898)		44°.10 F.
Wind, velocity per hour	miles	10.6
Humidity, percentage of saturation (mean 1882–1898)	per cent	74.9

These results are apparently consistent with each other, at least within the limits of the accuracy of the data. Formerly there was a marked inconsistency between the derived discharges of the St. Clair and Niagara and St. Lawrence rivers, the St. Clair being nearly as large as the Niagara, and the St. Lawrence being very much larger than the Niagara. The investigations of ice effects, made by the United States lake survey, has reduced the derived discharge of both the St. Clair and the St. Lawrence rivers, so that now their relation to the derived discharge of the Niagara is entirely reasonable, and there is no longer cause for the theory that a part of the discharge from Lake Erie passes by underground percolation into Lake Ontario.

Very respectfully,

E. S. WHEELER,
Assistant Engineer.

Maj. WILLIAM H. BIXBY,
Corps of Engineers, U. S. Army.

APPENDIX A.

Memoranda prepared July 17, 1900, by Asst. Engineer E. S. Wheeler, for the discussion of the discharge observations made in St. Marys River at Sault Ste. Marie in 1896-1899, under the river and harbor office of Col. G. J. Lydecker, showing the data and methods used in determining formulæ for Lake Superior outflow.

Four separate groups of observations were made and two different cross sections used during 1896–1899. In 1896 Mr. E. E. Haskell made 54 measurements at the Spry dock section and 11 measurements at the bridge section. The former were published in the Annual Report of the Chief of Engineers for 1897. In 1899 Mr. T. Russell made 65 measurements at the Spry dock section and 34 at the bridge section.

The measurements at Spry dock section include the entire outflow from Lake Superior; those at the bridge section include only the flow which passes under the bridge. A gauge at the south end of the bridge was read for all four groups. This

gauge is in span 1, which is a part of the Chandler-Dunbar canal; its relation to the bowlder gauge was determined by several sets of simultaneous observations, as follows:

Gauge at bridge.	Gauge at bowlder.	Gauge at bridge.	Gauge at bowlder.	Gauge at bridge.	Gauge at bowlder.	Gauge at bridge.	Gauge at bowlder.
Feet.		*Feet.*		*Feet.*		*Feet.*	
600.70	+ .17	.80	.22	.07	.16	.27	.18
.83	.17	.80	.21	.15	.16	.28	.18
.94	.10	.81	.13	.16	.17	.35	.18
601.00	.15	.85	.18	.17	.14	.36	.18
.60	.25	.86	.19	.19	.18	.37	.19
.75	.15	.97	.17	.19	.16	.48	.18
.77	.18	602.00	.21	.21	.18	.52	.17

The mean of this determination is 0.17 feet; and a comparison of these observations does not indicate any change due to stage. The difference between the gauge at the bowlder and at the bridge was therefore taken as 0.17 feet at all stages, and the bridge gauge readings were increased by this amount, so that in the following discussion all gauge readings have been reduced to and referred to the gauge at the west end of the southwest canal pier.

In order to make the four groups of measurements comparable with each other, the two Spry dock groups were diminished by the amount that was passing outside of the bridge at the time the observations were made. The outside flow was measured in 1896 and found to be 5,000 s–f at stage 601.17, with an increment of 950 s–f for each foot of rise in the gauge. In 1899 the outside flow was found to be 10,768 s–f at stage 601.17, with the same increment of 950 s–f for each foot of rise in the gauge. The flow under the bridge resulting from such measurements and corrections is as given in the following tables:

[From current measurements made at Spry dock in 1896 by E. E. Haskell.]

Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.
Feet.	*S–f.*	*Feet*	*S–f.*	*Feet.*	*S–f.*
600.85	[a]55,799	601.33	60,023	601.52	66,162
601.03	55,238	.35	63,704	.54	63,253
.07	56,250	.36	62,354	.58	65,305
.07	56,690	.36	64,304	.58	65,045
.09	55,521	.37	63,045	.59	65,426
.20	60,106	.37	60,605	.59	66,846
.25	57,879	.38	63,575	.59	65,886
.25	59,869	.40	62,856	.60	67,086
.26	62,049	.42	64,517	.61	63,207
.26	62,320	.43	63,048	.62	64,467
.27	60,550	.43	63,648	.63	66,838
.27	61,020	.44	62,968	.65	66,409
.28	60,971	.45	66,139	.71	69,642
.28	60,131	.45	64,059	.72	[a]64,652
.29	59,381	.46	60,469	.82	69,227
.30	63,971	.47	64,010	.82	71,697
.31	61,042	.47	63,870		
.32	61,232	.51	63,282	601.41	62,920
.33	61,702	.51	62,912	Increment, 17.139.	

[a] These figures are questionable.

[From current measurements made at Spry dock in 1899 by T. Russell.]

Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.
Feet.	*s-f*	*Feet.*	*s-f*	*Feet.*	*s-f*
600.83	53,837	601.10	56,481	601.19	57,050
.87	53,753	.10	58,081	.19	56,732
.90	54,894	.11	56,519	.19	58,597
.90	55,552	.11	56,702	.19	56,297
.93	54,954	.11	59,800	.20	58,631
.93	54,990	.11	58,825	.20	58,598
.96	55,128	.13	57,507	.20	56,730
.97	52,423	.13	57,752	.21	57,523
.97	51,877	.13	55,095	.22	58,284
.99	56,406	.14	56,000	.22	58,508
601.00	55,440	.14	52,567	.23	58,011
.00	53,881	.14	58,603	.23	58,141
.04	55,730	.15	56,419	.29	59,864
.05	55,660	.15	57,920	.38	54,550?
.06	56,817	.15	58,469	.46	63,558
.06	54,497	.15	57,020	.51	63,722
.06	55,664	.16	58,138	.54	65,075
.08	58,420	.16	56,440	.55	58,895?
.08	55,601	.16	56,958	.57	54,589?
.08	55,337	.17	57,259		
.08	55,895	.17	54,382	601.12	56,936
.08	57,191	.18	59,647	Increment, 15,993.	
.10	54,633	.18	59,553		

[From current measurements made at bridge in 1896 by E. E. Haskell.]

Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.
Feet.	*s-f*	*Feet.*	*s-f*	*Feet.*	*s-f*
601.28	69,540	601.90	80,287	602.22	85,276
.36	68,309	.92	78,518		
.48	70,028	.97	81,942	601.81	77,802
.78	77,052	602.06	81,386	Increment, 18,227.	
.85	79,102	.14	84,406		

[From current measurements made at the bridge in 1899 by T. Russell.]

Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.	Bowlder gauge.	Discharge.
Feet.	*s-f*	*Feet.*	*s-f*	*Feet.*	*s-f*
601.61	69,921	602.26	80,676	602.52	86,395
.69	71,468	.27	80,831	.53	84,210
.86	74,252	.29	80,598	.54	85,722
.95	76,047	.32	81,668	.56	85,212
.98	76,176	.33	82,708	.64	87,598
602.12	78,577	.34	81,950	.64	86,602
.13	77,469	.39	83,103	.65	88,072
.17	79,300	.44	84,914	.67	87,850
.21	79,036	.45	83,880	67	86,735
.21	81,297	.47	83,287	603.26	97,195
.24	80,433	.49	84,395		
.25	81,835	.52	85,184	602.31	82,194
				Increment, 16,426.	

These groups have also been discussed and platted separately, the discharge in each case being represented graphically by a straight line.

In their discussions the groups were given different weights due to the number of observations, range in gauge readings, and accuracy of rating, and the discharge at the mean stage was found by giving to each group a weight equal to the product of its rating into the square root of the number of observations.

The relative weight was assigned as follows:

Spry dock:
- 1896 10
- 1899 8

Bridge:
- 1899 3
- 1896 1

The number of observations was as follows:

Spry dock:
- 1896 52
- 1899 62

Bridge:
- 1899 34
- 1896 11

The results of the four groups were then:

	Date.	Gauge.	Discharge.	Weight.
Spry dock	1896	601.41	62,920	$10\times\sqrt{52}$
Do	1899	601.12	56,936	$8\times\sqrt{62}$
Bridge	1899	602.31	82,194	$3\times\sqrt{34}$
Do	1896	601.81	77,802	$1\times\sqrt{11}$

Giving at stage 601.402 a discharge of 63,000 s-f.

The increase in discharge for 1 foot change in gauge was found by giving to each group a weight equal to the product of its rating and range in gauge reading, as follows:

Spry dock:
- 1896 ..... 17,139 10×10
- 1899 ..... 15,963 8×7

Bridge:
- 1899 ..... 16,426 3×17
- 1896 ..... 18,227 1×9

Giving 16,706 s-f. as the change in discharge for 1 foot change in gauge reading; and at gauge 600, a discharge of 39,578 s-f; and a discharge equation of—

$$(1)\ \text{Discharge}=39{,}578+16{,}706\times(\text{gauge}-600),$$

applicable to the discharge under 8 spans of the bridge, not including spans 1 and 2, which are in the Chandler-Dunbar Water Power Canal.

The observations show that the discharge curve may be taken as a linear function of elevation without appreciable error, at least within the small range of elevation used. To obtain the total flow in the river there must be added the flow through the Canadian Water Power, the Chandler-Dunbar Water Power, the two ship canals, and the two small streams on the Canadian side.

The flow through the river before the building of the bridge will first be determined. From a report (with sketches) of Asst. Engineer E. E. Haskell, dated June 11, 1896,[a] it is found that the building of the bridge and approaches and other works (largely in shallow parts of the river), done between 1887 and 1892, diminished the cross-section of the river (at stage 601.53) 38 per cent in width and 26.4 per cent in area, diminished the discharge 14 per cent, and increased the mean velocity 17 per cent. (The sketch which accompanies Mr. Haskell's report shows that the width of the cross-section before 1888 was 4,200 feet and after the obstructions were made was only 2,600 feet.) From this data it is possible to determine the discharge equation before 1888. First, by the preceding equation the discharge is zero at stage 597.63, and therefore (assuming the discharge curve to be a straight line) 597.63 must be the elevation of the bottom of the river. This would be equally true before the obstructions were made, and therefore there is already one gauge reading, viz, 597.63, at which the discharge before 1888 is known. If now the increment for unit of gauge can be determined the discharge equation will be complete. Since the discharge after obstruction is 14 per cent less than before, the increment after obstruction must be 14 per cent less than the increment before. Since the increment after obstruction is 16,706 s-f, it follows that the increment before was 19,429 s-f. Since the discharge is zero at gauge 597.63, the discharge at gauge 600 is 46,047 s-f, and a new discharge equation may be written,

$$(2)\ \text{Discharge}=46{,}047+19{,}429\times(\text{gauge}-600),$$

applicable to all gauge readings before 1888.

[a] Not published.

Between 1888 and 1895 the only outside flow was through two small streams on the Canadian side and through the United States canal. The amount of this flow is estimated as 1,674 s-f at stage 601.53, with an increment of 950 s-f for foot of rise. Adding the corrections to equation (1) there results the following:

$$(3)\ \text{Discharge}=39{,}798+17{,}656\times(\text{gauge}-600),$$

applicable to all gauge readings from 1888 to 1895, both years inclusive.

The outside flow from 1896 to 1898 includes the two ship canals, the two water powers, and the two small streams; the total is estimated as 5,000 s-f at stage 601.17 with an increment of 950 s-f for each foot of rise. Adding these amounts to equation (1) there results the following,

$$(4)\ \text{Discharge}=43{,}466+17{,}656\times(\text{gauge}-600),$$

applicable to all gauge readings from 1896 to 1898, inclusive.

In 1899 both water powers had been enlarged, and it is estimated that the total outside flow at stage 601.17 was 10,768 with an increment of 950 s-f. Adding these corrections to equation (1) there results,

$$(5)\ \text{Discharge}=49{,}235+17{,}656\times(\text{gauge}-600),$$

applicable to gauge readings in 1899 and until further changes are made in the outside flow.

Collecting the equations, the relation between discharge and gauge at southwest canal pier is therefore assumed as follows:

Equation for discharge through eight spans of the bridge,

$$\text{Discharge}=39{,}578+16{,}706\times(\text{gauge}-600) \quad (1)$$

Equation for total discharge before 1888,

$$\text{Discharge}=46{,}047+19{,}429\times(\text{gauge}-600) \quad (2)$$

Equation for total discharge from 1888 to 1895, inclusive,

$$\text{Discharge}=39{,}798+17{,}656\times(\text{gauge}-600) \quad (3)$$

Equation for total discharge from 1896 to 1898, inclusive,

$$\text{Discharge}=43{,}466+17{,}656\times(\text{gauge}-600) \quad (4)$$

Equation for discharge in 1899 and until further changes are made,

$$\text{Discharge}=49{,}235+17{,}656\times(\text{gauge}-600) \quad (5)$$

TABLE I.—*Showing, in feet, the mean monthly elevation of Lake Superior above locks at St. Marys Falls Canal.*

Date.	January.	February.	March.	April.	May.	June.
1860	601.99	601.74	601.74	602.24	602.47	602.64
1861	602.03	601.70	601.56	601.97	602.60	602.75
1862	601.74	601.55	601.58	601.64	602.32	602.31
1863	601.71	601.58	601.41	601.45	601.58	601.50
1864	601.36	601.15	601.22	601.24	601.40	601.55
1865	601.02	601.01	600.88	601.32	601.81	602.22
1866	601.29	601.08	601.08	601.53	601.78	601.97
1867	601.75	601.64	601.45	601.67	601.67	602.27
1868	601.63	601.04	601.40	601.59	601.99	601.90
1869	601.65	601.41	600.96	601.54	601.94	601.95
1870	601.87	601.66	601.67	601.77	602.10	601.91
1871	601.165	601.002	600.738	600.869	601.446	601.856
1872	600.948	600.864	600.628	600.580	601.469	601.647
1873	601.285	601.109	601.138	601.152	601.709	601.845
1874	601.471	601.314	601.205	601.084	601.501	601.930
1875	601.696	601.448	601.407	601.657	601.961	602.267
1876	601.644	601.592	601.337	601.373	602.097	602.676
1877	601.835	601.860	601.746	601.621	601.625	601.848
1878	601.473	601.215	601.114	601.098	601.373	601.630
1879	600.825	600.425	600.182	600.311	600.685	600.824
1880	600.328	600.293	600.199	600.217	600.957	601.714
Mean	601.462	601.270	601.173	601.329	601.737	601.962

TABLE I.—*Showing, in feet, the mean monthly elevation of Lake Superior above locks at St. Marys Falls Canal*—Continued.

Date.	July	August.	September.	October.	November.	December.
1860	602.60	602.65	602.63	602.67	602.50	602.14
1861	602.91	602.87	602.78	602.81	602.47	602.09
1862	602.28	602.45	602.57	602.50	602.17	601.90
1863	601.64	602.26	602.28	602.11	601.76	601.65
1864	601.64	601.65	601.80	601.54	601.35	601.20
1865	602.54	602.62	602.63	602.42	601.89	601.58
1866	602.26	602.49	602.22	602.24	601.91	602.02
1867	602.60	602.48	602.56	602.54	602.11	601.79
1868	602.12	602.04	602.17	602.14	602.30	601.87
1869	602.32	602.78	603.63	603.11	602.77	602.12
1870	602.10	602.10	602.27	602.11	601.93	601.00
1871	602.035	601.954	602.005	601.805	601.583	601.190
1872	602.041	602.367	602.430	602.284	602.137	601.682
1873	602.288	602.536	602.598	602.480	602.259	602.027
1874	602.307	602.364	602.348	602.477	602.257	602.150
1875	602.346	602.363	602.643	602.512	602.233	601.672
1876	603.145	603.191	603.228	602.890	602.612	602.126
1877	602.177	602.289	602.055	602.092	601.855	601.689
1878	601.741	601.699	601.418	691.526	601.444	601.222
1879	601.124	601.152	601.075	601.099	600.921	600.523
1880	601.956	601.835	601.991	601.767	601.791	601.517
Mean	602.198	602.292	602.349	602.101	602.012	601.674

Date.	January.	February.	March.	April.	May.	June.
1881	601.199	601.105	601.126	601.011	601.437	601.665
1882	601.489	601.271	601.154	601.103	601.514	601.608
1883	601.145	601.049	601.056	601.123	601.118	601.485
1884	601.131	600.940	600.854	600.684	601.055	601.150
1885	601.247	601.135	600.998	600.822	601.406	601.741
1886	601.004	600.839	600.846	600.822	601.301	601.467
1887	600.945	600.802	600.773	600.631	600.995	601.443
1888	600.945	600.594	600.645	600.635	601.236	602.085
1889	601.328	601.038	601.060	601.055	601.616	601.795
1890	601.284	600.730	600.723	600.657	601.120	601.704
1891	600.662	600.773	600.627	600.801	601.231	601.180
1892	600.815	600.457	600.277	600.429	600.940	601.300
1893	600.589	600.391	600.405	600.649	601.225	601.757
1894	601.035	600.951	600.841	601.232	602.204	602.444
1895	601.801	601.665	601.464	601.443	601.845	602.233
1896	601.493	601.487	601.288	601.369	601.986	602.397
1897	601.722	601.415	601.431	601.567	601.910	602.270
1898	601.182	600.956	600.803	601.038	601.221	601.636
1899	601.333	601.177	601.067	601.061	601.919	602.367
1900	601.877	601.786	601.609	601.624	601.816	601.775
1901	602.087	601.824	601.572	601.707	602.088	602.044
1902	601.74	601.57	601.49	601.56	602.90	602.17
Mean	601.275	601.089	601.005	601.046	601.549	601.805

Date.	July.	August.	September.	October.	November.	December.
1881	601.868	601.788	601.969	602.437	602.334	602.008
1882	601.952	602.057	601.990	601.906	601.840	601.573
1883	601.661	602.088	601.752	601.608	601.489	601.229
1884	601.372	601.417	601.484	601.569	601.677	601.413
1885	601.919	602.146	601.904	601.721	601.649	601.353
1886	601.632	601.778	601.634	601.662	601.598	601.162
1887	601.813	601.696	601.555	601.729	601.500	601.095
1888	602.242	602.237	602.156	602.140	601.941	601.602
1889	602.063	602.070	602.063	601.916	601.617	601.229
1890	602.065	601.974	601.863	602.119	601.656	601.352
1891	601.292	601.304	601.238	601.294	601.185	600.920
1892	601.440	601.451	601.509	601.400	601.123	600.841
1893	601.952	602.036	601.906	601.847	601.792	601.253
1894	602.582	602.591	602.459	602.501	602.402	602.101
1895	602.469	602.487	602.658	602.777	602.256	602.048
1896	602.528	602.545	602.411	601.986	602.015	601.951
1897	602.498	602.654	602.488	602.271	602.167	601.676
1898	601.974	602.086	602.223	602.068	601.897	601.810
1899	602.567	602.718	602.905	602.571	602.613	602.453
1900	602.041	602.245	602.729	602.854	602.879	602.490
1901	602.413	602.634	602.506	602.574	602.519	602.139
1902	602.40	602.38	602.42	602.32	602.35	602.07
Mean	602.033	602.108	602.087	602.057	601.913	601.626

TABLE II.—*Showing, in feet, the mean monthly elevation of Lakes Huron and Michigan at Sand Beach.*

Date.	January.	February.	March.	April.	May.	June.
1860	582.32	582.27	582.41	582.38	582.43	582.67
1861	581.48	581.52	581.66	581.86	582.48	582.82
1862	581.93	581.92	581.83	582.04	582.41	582.53
1863	581.85	581.70	581.65	581.72	582.04	582.17
1864	581.28	581.24	581.24	581.44	581.87	581.88
1865	580.21	580.30	580.47	580.96	581.12	581.16
1866	580.12	579.88	579.93	580.38	580.56	580.85
1867	580.54	580.59	580.77	581.06	581.28	581.59
1868	580.10	580.06	580.74	580.64	580.92	581.13
1869	579.90	579.97	579.71	580.08	580.41	580.94
1870	580.77	580.86	581.16	581.58	581.92	582.06
1871	581.22	581.14	581.74	581.94	582.29	582.33
1872	580.48	580.28	579.78	580.20	580.60	581.00
1873	580.09	580.06	580.13	580.54	581.04	581.44
1874	581.21	581.35	581.49	581.34	581.39	581.73
1875	580.65	580.59	580.63	580.82	581.17	581.48
1876	581.23	581.21	581.34	581.62	582.22	582.71
1877	581.95	581.94	581.87	581.95	582.12	582.08
1878	581.55	581.38	581.55	581.48	581.88	582.05
1879	581.02	580.78	580.74	580.77	580.90	581.04
1880	580.54	580.48	580.47	580.48	580.88	581.37
Mean	580.973	580.929	581.015	581.204	581.520	581.763

Date.	July.	August.	September.	October.	November.	December.
1860	582.76	582.68	582.49	582.11	581.99	581.69
1861	582.94	583.05	582.97	582.75	582.44	582.31
1862	582.58	582.56	582.34	582.62	582.30	582.01
1863	582.08	582.09	581.95	581.69	581.65	581.42
1864	581.83	581.72	581.40	580.87	580.70	580.57
1865	581.59	581.61	581.49	581.25	580.69	580.38
1866	581.11	581.17	581.02	580.91	580.82	580.56
1867	581.74	581.67	581.40	581.07	580.61	580.26
1868	581.16	580.82	580.58	580.35	580.28	580.00
1869	581.32	581.58	581.47	581.11	580.99	580.71
1870	582.17	582.08	582.22	581.82	581.42	581.07
1871	582.36	582.05	581.73	581.23	581.02	580.65
1872	581.10	581.07	580.97	580.85	580.55	580.26
1873	581.64	581.65	581.48	581.45	581.35	581.19
1874	581.89	581.78	581.60	581.33	580.79	580.94
1875	581.67	581.64	581.68	581.49	581.38	581.11
1876	583.15	583.09	582.98	582.58	582.43	582.24
1877	582.26	582.16	581.89	581.75	581.70	581.65
1878	582.09	581.99	581.70	581.71	581.52	581.32
1879	581.08	580.95	580.87	580.63	580.51	580.49
1880	581.68	581.57	581.46	581.10	580.98	580.78
Mean	581.914	581.856	581.700	581.460	581.244	581.029

Date.	January.	February.	March.	April.	May.	June.
1881	580.65	581.04	581.05	581.07	581.39	581.56
1882	581.44	581.21	581.35	581.57	581.74	581.97
1883	581.22	581.17	581.21	581.22	581.79	582.21
1884	582.05	581.90	581.94	582.25	582.47	582.53
1885	581.96	581.87	581.87	581.98	582.38	582.67
1886	582.16	582.23	582.42	582.71	583.04	583.13
1887	581.75	581.94	582.15	582.06	582.26	582.38
1888	580.83	580.74	580.91	581.05	581.49	581.79
1889	580.74	580.66	580.64	580.57	580.71	581.04
1890	580.27	580.15	580.13	580.27	580.58	581.01
1891	580.02	579.91	579.88	580.21	580.45	580.40
1892	579.42	579.36	579.42	579.50	579.63	580.16
1893	579.33	579.28	579.36	579.74	580.37	581.12
1894	579.72	579.73	579.88	580.11	580.51	580.81
1895	579.52	579.40	579.41	579.51	579.68	579.75
1896	578.65	578.77	578.67	578.70	579.10	579.47
1897	579.01	578.92	579.06	579.40	579.97	580.21
1898	579.22	579.28	579.51	580.00	580.12	580.28
1899	579.24	579.10	579.25	579.42	579.96	580.35
1900	579.38	579.39	579.42	579.54	579.69	579.86
1901	579.78	579.64	579.63	580.10	580.31	580.41
1902	579.51	579.31	579.22	579.45	579.66	580.05
Mean	580.267	580.227	579.380	580.474	580.786	581.052

TABLE II.—*Showing, in feet, the mean monthly elevation of Lakes Huron and Michigan at Sand Beach*—Continued.

Date.	July.	August.	September.	October.	November.	December.
1881	581.71	581.54	581.38	581.63	581.76	581.59
1882	582.11	582.17	582.05	581.82	581.57	581.42
1883	582.69	582.89	582.57	582.24	582.35	582.24
1884	582.61	582.49	582.14	582.30	581.95	581.69
1885	582.73	582.88	582.78	582.55	582.36	582.16
1886	582.97	582.82	582.64	582.51	582.24	581.92
1887	582.46	582.25	581.90	581.68	581.23	580.94
1888	581.82	581.86	581.56	581.27	581.09	580.88
1889	581.30	581.24	581.07	580.70	580.36	580.20
1890	581.20	581.20	580.93	580.72	580.52	580.22
1891	580.43	580.33	580.14	579.77	579.46	579.40
1892	580.45	580.53	580.36	580.15	580.82	579.58
1893	580.84	580.70	580.41	580.20	579.97	579.77
1894	580.96	580.69	580.50	580.26	580.07	579.77
1895	579.72	579.63	579.50	579.21	578.82	578.58
1896	579.53	579.57	579.39	579.19	579.05	578.93
1897	580.39	580.40	580.14	579.79	579.67	579.37
1898	580.38	580.27	580.08	579.77	579.69	579.50
1899	580.64	580.55	580.35	579.94	579.80	579.61
1900	580.11	580.20	580.28	580.22	580.22	580.02
1901	580.59	580.66	580.38	580.17	579.93	579.60
1902	580.28	580.32	580.07	579.76	579.68	579.45
Mean	581.178	581.145	580.936	580.720	580.572	580.311

TABLE III.—*Showing, in feet, the mean monthly elevation of Lake St. Clair at St. Clair Flats Canal.*

Date.	June.	July.	August.	September.	October.	November.
1860	*577.08*	*577.00*	*576.89*	*576.66*	*576.37*	*576.28*
1861	*577.20*	*577.13*	*577.20*	*577.08*	*576.89*	*576.75*
1862	*577.13*	*577.14*	*576.96*	*576.73*	*576.67*	*576.38*
1863	*576.72*	*576.63*	*576.60*	*576.37*	*576.06*	*575.86*
1864	*576.69*	*576.36*	*576.19*	*575.96*	*575.60*	*575.46*
1865	*575.94*	*576.10*	*576.07*	*576.00*	*575.77*	*575.37*
1866	*575.83*	*575.99*	*575.90*	*575.81*	*575.76*	*575.62*
1867	*576.36*	*576.34*	*576.17*	*575.88*	*575.59*	*575.18*
1868	*576.05*	*576.05*	*575.68*	*575.46*	*575.16*	*575.06*
1869	*575.98*	*576.26*	*576.32*	*576.15*	*575.80*	*575.54*
1870	*576.62*	*576.68*	*576.62*	*576.57*	*576.23*	*575.94*
1871	*576.56*	*576.57*	*576.35*	*576.14*	*575.63*	*575.47*
1872	*575.53*	575.41	575.55	575.41	575.39	574.90
1873	576.10	576.24	576.23	576.00	575.75	575.56
1874	576.17	576.34	576.25	576.04	575.80	575.51
1875	575.89	576.12	576.05	575.90	575.73	575.55
1876	577.46	577.62	577.45	576.98	576.65	576.54
1877	576.22	576.47	576.38	576.13	*576.05*	576.18
1878	576.62	576.74	576.65	576.31	576.12	575.79
1879	*575.88*	*575.91*	*575.76*	*575.58*	*575.37*	*575.11*
1880	*576.13*	*576.30*	*576.15*	575.97	575.72	*575.57*
Mean	576.39	576.45	576.35	576.15	575.91	575.70

Date.	June.	July.	August.	September.	October.	November.
1881	576.33	576.40	576.32	576.01	575.81	*575.92*
1882	577.30	577.35	577.34	577.18	*576.29*	576.11
1883	577.01	577.68	577.60	577.14	576.77	576.33
1884	577.27	577.32	577.03	576.67	576.45	576.08
1885	577.04	576.95	577.06	576.91	576.59	576.55
1886	576.98	576.99	576.87	576.72	576.56	576.22
1887	576.80	576.80	576 62	576.34	576.01	575.59
1888	575.98	576.27	576.17	575.93	575.65	575.52
1889	575.85	575.99	575.85	575.64	575.25	574.97
1890	576.28	576.21	575.97	575.73	575.51	575.48
1891	575.23	575.30	575.19	575.06	574.74	574.50
1892	575.63	575.83	575.65	575.54	575.09	574.70
1893	575.76	575.80	575.62	575.36	575.10	574.82
1894	575.63	575.67	575.47	575.32	575.06	574.82
1895	574.57	574.63	574.59	574.47	574.07	573.78
1896	574.64	574.81	574.97	574.65	574.55	574.09
1897	575.22	575.37	575.34	575.08	574.72	574.55
1898	575.43	575.48	575.34	575.07	574.81	574.76
1899	575.28	575.45	575.39	575.08	574.78	574.65
1900	575.09	575.17	575.22	575.10	574.94	574.82
1901	574.97	575.18	575.18	575.16	574.84	574.55
1902	575.01	575.64	575.50	575.18	575.11	574.83
Mean	575.88	576.01	575.92	575.70	575.40	575.17

TABLE IV.—*Showing, in feet, the mean monthly elevation of Lake Erie at Cleveland.*

Date.	January.	February.	March.	April.	May.	June.
1860	573.35	572.99	573.39	574.09	574.30	574.27
1861	572.70	572.42	572.86	573.90	574.33	574.40
1862	573.52	573.23	573.37	574.27	574.51	574.51
1863	573.55	573.84	573.78	573.90	574.08	573.94
1864	572.18	572.33	572.54	573.04	573.74	573.69
1865	572.10	571.52	571.84	572.56	573.14	573.12
1866	571.87	571.71	572.10	572.68	572.90	573.16
1867	572.43	572.01	572.51	572.83	573.35	573.66
1868	571.51	571.13	571.72	572.55	573.00	573.39
1869	571.74	571.67	572.15	572.45	573.00	573.39
1870	572.98	573.21	572.98	573.63	573.84	573.81
1871	572.54	572.21	572.66	573.14	573.41	573.44
1872	571.67	571.43	571.34	571.54	571.98	572.35
1873	571.25	571.26	571.33	572.61	573.28	573.36
1874	573.14	573.19	573.22	573.39	573.48	573.55
1875	571.66	571.49	571.63	572.03	572.50	572.93
1876	572.45	573.01	573.66	574.18	574.50	574.61
1877	572.84	572.68	572.45	572.88	573.13	573.21
1878	572.91	573.05	573.18	573.60	573.86	573.86
1879	572.60	572.46	572.49	572.85	573.00	573.09
1880	572.63	572.67	572.81	572.97	573.24	573.35
Mean	572.458	572.357	572.095	573.099	573.455	573.575

Date.	July.	August.	September.	October.	November.	December.
1860	574.01	573.85	573.51	573.21	573.12	572.96
1861	574.15	574.19	574.01	573.78	573.76	573.53
1862	574.48	574.10	573.79	573.41	573.07	573.10
1863	573.82	573.74	573.35	572.91	572.50	572.47
1864	573.43	573.16	572.94	572.63	572.46	572.53
1865	573.08	573.00	572.96	572.66	572.28	572.14
1866	573.27	573.02	572.96	572.95	572.71	572.72
1867	573.47	573.16	572.77	572.43	571.93	571.71
1868	573.36	572.84	572.57	572.12	571.96	571.75
1869	573.67	573.57	573.30	572.85	572.39	572.74
1870	573.85	573.80	573.55	573.17	572.87	572.75
1871	573.42	573.21	573.04	572.37	572.19	571.75
1872	572.34	572.31	572.08	571.91	571.58	571.35
1873	573.34	573.28	572.88	572.58	572.38	572.75
1874	573.58	573.42	572.96	572.52	572.10	571.89
1875	573.06	573.05	572.91	572.42	572.27	572.49
1876	574.50	574.20	574.03	573.50	573.58	573.24
1877	573.45	573.31	573.23	572.83	572.75	572.83
1878	573.86	573.62	573.49	573.14	572.94	573.02
1879	573.12	572.90	572.57	572.34	571.87	572.13
1880	573.44	573.20	572.97	572.53	572.45	572.11
Mean	573.557	573.377	573.136	572.774	572.531	572.474

Date.	January.	February.	March.	April.	May.	June.
1881	571.70	571.81	572.13	572.83	573.23	573.47
1882	573.20	573.20	573.65	573.87	574.07	574.22
1883	572.37	572.58	572.77	572.89	573.35	574.05
1884	572.88	573.14	573.33	573.88	574.15	574.23
1885	572.36	572.15	572.01	572.83	573.56	574.07
1886	573.64	572.91	572.72	573.60	573.90	574.00
1887	572.70	573.13	573.91	573.96	574.14	574.16
1888	572.36	572.09	572.19	572.82	573.07	573.20
1889	572.40	572.24	572.08	572.43	572.61	573.04
1890	572.47	572.76	572.88	573.37	573.71	574.08
1891	572.40	572.38	572.84	572.71	572.53	572.67
1892	571.40	571.19	571.23	571.79	572.59	573.35
1893	571.26	571.34	571.56	572.29	573.13	573.32
1894	571.93	571.81	571.84	572.24	572.63	572.84
1895	571.32	571.09	571.10	571.35	571.57	571.66
1896	571.05	570.97	570.92	571.37	571.75	572.02
1897	571.18	571.38	571.75	572.30	572.63	572.73
1898	571.68	571.88	572.14	572.72	572.87	572.90
1899	571.76	571.55	571.92	572.22	572.53	572.65
1900	571.45	571.66	572.01	572.32	572.48	572.56
1901	571.44	571.09	570.97	571.38	571.40	571.81
1902	571.17	570.72	571.04	571.58	571.95	572.21
Mean	572.01	571.96	572.14	572.58	572.90	573.15

TABLE IV.—*Showing, in feet, the mean monthly elevation of Lake Erie at Cleveland*—Continued.

Date.	July.	August.	September.	October.	November.	December.
1881	573.42	573.10	572.75	572.70	572.52	572.73
1882	574.15	574.01	573.74	573.29	572.97	572.46
1883	574.25	574.19	573.88	573.56	573.18	573.21
1884	574.01	573.85	573.42	573.09	572.61	572.54
1885	574.03	574.04	573.89	573.79	573.67	573.62
1886	573.98	573.78	573.53	573.30	573.01	572.93
1887	573.93	573.61	573.38	572.79	572.52	572.54
1888	573.35	573.25	572.81	572.44	572.50	572.38
1889	573.24	572.93	572.54	572.12	571.85	572.11
1890	573.70	573.26	573.07	572.88	572.85	572.62
1891	572.57	572.30	572.12	571.74	571.30	571.37
1892	573.47	573.12	572.80	572.24	571.91	571.64
1893	573.04	572.70	572.32	571.97	571.57	571.65
1894	572.82	572.45	572.28	571.96	571.72	571.65
1895	571.55	571.47	571.37	570.89	570.79	570.95
1896	571.90	572.11	571.79	571.55	571.18	571.21
1897	572.72	572.56	572.28	571.79	571.66	571.63
1898	572.68	572.48	572.10	571.90	571.78	571.61
1899	572.37	572.18	571.94	571.70	571.71	571.43
1900	572.43	572.40	572.08	571.84	571.58	571.54
1901	572.00	571.87	571.80	571.42	571.25	571.28
1902	572.83	572.81	572.47	572.38	572.11	571.91
Mean	573.11	572.93	572.65	572.33	572.10	572.05

TABLE V.—*Showing, in feet, the mean monthly elevation of Lake Ontario at Oswego.*

Date.	January.	February.	March.	April.	May.	June.
1860	246.67	246.81	246.86	246.89	247.12	247.66
1861	246.53	246.65	247.11	247.32	248.27	248.63
1862	247.20	246.78	247.27	248.17	248.97	248.71
1863	246.86	246.92	247.00	247.72	248.12	248.27
1864	246.42	246.26	246.35	246.92	247.91	248.21
1865	247.17	247.32	247.47	247.55	247.71	247.75
1866	245.55	245.56	245.57	246.05	246.11	246.01
1867	246.04	246.01	246.71	247.61	248.30	248.57
1868	244.60	244.70	244.97	245.61	246.21	246.63
1869	245.31	245.43	245.65	246.18	246.84	247.06
1870	247.35	247.50	247.50	248.44	249.04	248.72
1871	246.15	245.98	246.19	246.79	247.21	247.15
1872	244.82	244.60	244.44	244.93	245.05	245.38
1873	244.40	244.47	244.59	246.55	247.09	247.01
1874	246.44	246.84	247.39	247.28	247.26	247.35
1875	244.82	244.47	244.73	245.53	245.80	245.96
1876	245.40	246.06	246.61	247.59	248.17	248.39
1877	245.98	245.71	245.86	246.55	246.62	246.52
1878	245.57	245.78	246.48	246.73	247.07	247.06
1879	246.90	246.54	246.39	246.80	246.89	246.92
1880	245.41	245.69	246.03	246.21	246.36	246.60
Mean	245.980	246.004	246.246	246.830	247.244	247.360

Date.	July.	August.	September.	October.	November.	December.
1860	247.91	247.35	246.95	246.76	246.84	246.82
1861	248.41	248.16	247.69	247.90	247.91	247.70
1862	248.81	248.35	247.72	247.17	246.82	246.71
1863	247.86	247.40	247.02	246.83	246.65	246.66
1864	247.89	247.43	246.90	246.67	246.64	246.74
1865	247.60	246.99	246.38	246.16	245.91	245.75
1866	246.93	246.83	246.74	246.61	246.37	246.29
1867	248.20	247.57	247.07	246.42	245.68	244.92
1868	246.51	246.22	246.03	245.44	245.29	245.46
1869	247.38	247.44	247.26	247.17	246.77	246.94
1870	248.40	248.06	247.37	247.04	246.47	246.22
1871	246.99	246.55	246.21	245.71	245.30	244.99
1872	245.44	245.28	244.99	244.83	244.78	244.44
1873	246.97	246.69	246.27	245.82	245.69	245.88
1874	247.30	247.07	246.43	246.03	245.46	245.12
1875	245.99	245.85	245.64	245.36	245.17	244.99
1876	248.46	248.00	247.39	247.05	246.69	246.51
1877	246.56	246.29	245.86	245.43	245.34	245.47
1878	247.02	246.94	246.68	246.42	246.30	247.11
1879	246.76	246.41	245.99	245.55	245.16	245.19
1880	246.61	246.18	245.81	245.40	245.36	245.19
Mean	247.333	247.003	246.638	246.274	246.030	245.957

TABLE V.—*Showing, in feet, the mean monthly elevation of Lake Ontario at Oswego*—Continued.

Date.	January.	February.	March.	April.	May.	June.
1881	244.83	244.82	245.48	245.90	246.08	246.30
1882	245.82	245.99	246.59	246.92	247.11	247.62
1883	245.41	245.47	245.71	246.23	246.88	247.58
1884	246.60	246.97	247.65	248.26	248.28	248.18
1885	246.23	245.96	245.68	246.36	247.16	247.53
1886	247.69	247.76	247.90	248.52	248.73	248.53
1887	246.26	247.01	247.52	247.73	248.29	248.25
1888	245.53	245.39	245.63	246.26	246.33	246.37
1889	245.71	245.85	246.02	246.26	246.41	246.72
1890	246.34	246.69	247.02	247.26	247.62	248.25
1891	246.28	246.54	247.08	247.56	247.34	246.92
1892	244.60	244.57	244.70	245.28	245.34	245.90
1893	244.96	244.85	245.33	246.08	247.24	247.46
1894	245.65	245.83	246.13	246.18	246.36	246.89
1895	244.58	244.52	244.42	244.97	245.09	244.97
1896	243.89	244.41	244.58	245.51	245.52	245.43
1897	243.97	243.91	244.41	245.05	245.49	245.71
1898	244.73	245.17	245.57	246.01	246.17	246.22
1899	245.07	244.97	245.22	245.78	246.03	246.16
1900	244.60	244.91	245.20	245.89	246.08	246.00
1901	244.77	244.71	244.48	245.72	246.01	246.11
1902	244.59	244.54	245.33	245.66	245.64	245.69
Mean	245.368	245.492	245.802	246.335	246.600	246.763

Date.	July.	August.	September.	October.	November.	December.
1881	246.37	246.05	245.49	245.27	245.27	245.27
1882	247.61	247.28	246.90	246.39	245.97	245.68
1883	248.11	247.93	247.45	247.01	246.78	246.64
1884	247.97	247.74	247.31	246.89	246.39	246.24
1885	247.67	247.52	247.30	247.11	247.16	247.33
1886	248.13	247.69	247.33	247.04	246.60	246.51
1887	247.97	247.46	246.85	246.46	246.11	245.84
1888	246.43	246.33	245.94	245.58	245.51	245.50
1889	246.91	246.66	246.10	245.66	245.26	245.83
1890	248.08	247.41	247.06	246.73	246.81	246.60
1891	246.64	246.20	245.77	245.13	244.53	244.50
1892	246.41	246.33	246.13	245.69	245.42	245.29
1893	247.20	246.66	246.39	245.87	245.46	245.31
1894	246.69	246.11	245.60	245.35	245.02	244.67
1895	244.68	244.43	244.09	243.75	243.50	243.53
1896	245.17	245.03	244.55	244.32	244.06	244.06
1897	245.70	245.69	245.19	244.56	244.50	244.56
1898	245.94	245.59	245.18	244.93	244.98	244.99
1899	246.01	245.55	245.05	244.62	244.52	244.45
1900	245.91	245.63	245.21	244.82	244.66	244.93
1901	246.08	245.72	245.31	244.92	244.73	244.67
1902	245.69					
Mean	246.698	246.429	246.010	245.624	245.392	245.253

TABLE VI.—*Showing, in s-f, the mean monthly discharge of St. Marys River.*

Date.	January.	February.	March.	April.	May.	June.
1860	84,711	79,853	79,853	89,568	94,037	97,340
1861	85,488	79,076	76,356	84,522	96,562	99,477
1862	79,853	76,162	76,745	77,911	91,122	90,928
1863	79,271	76,745	73,442	74,219	76,745	75,190
1864	72,470	68,390	69,750	70,139	73,248	76,162
1865	65,865	65,670	63,145	71,693	81,213	89,179
1866	71,110	67,030	67,030	75,773	80,631	84,322
1867	80,048	77,911	74,219	78,493	78,493	90,151
1868	77,716	66,253	73,248	76,939	84,711	82,962
1869	78,105	73,442	64,699	75,968	83,739	83,934
1870	82,379	78,299	78,493	80,436	86,848	83,156
1871	68,585	65,476	60,424	62,950	74,219	82,185
1872	64,505	74,996	58,287	57,316	74,608	78,105
1873	70,916	67,613	68,196	68,390	79,271	81,991
1874	74,608	71,499	69,362	67,030	75,190	83,545
1875	79,076	74,219	73,442	78,299	84,128	90,151
1876	77,910	76,939	72,082	72,665	86,848	98,117
1877	81,602	82,185	80,048	77,522	77,522	81,991
1878	74,607	69,556	67,613	67,419	72,665	77,716
1879	61,979	54,207	49,544	52,070	57,316	61,979
1880	52,459	51,681	49,933	50,321	64,699	79,271
Mean	74,441	71,295	63,853	71,878	79,706	84,183

TABLE VI.—*Showing, in s-f, the mean monthly discharge of St. Marys River*—Continued.

Date.	July.	August.	September.	October.	November.	December.
1860	96,562	97,534	97,145	98,311	94,619	87,625
1861	102,585	101,808	99,671	100,642	94,037	86,654
1862	90,345	93,648	95,980	94,619	88,208	82,962
1863	77,911	89,957	90,345	87,042	80,242	78,105
1864	77,911	78,105	81,019	75,968	72,276	69,362
1865	95,397	96,951	97,145	93,065	82,768	76,745
1866	89,957	94,425	89,179	89,568	81,213	85,294
1867	96,562	94,231	95,785	95,397	87,042	80,825
1868	87,236	85,682	88,208	87,625	90,734	82,379
1869	91,122	100,060	116,574	106,471	99,865	87,236
1870	86,848	86,848	90,151	87,042	83,545	65,476
1871	85,488	83,934	84,905	81,019	76,745	69,168
1872	85,682	92,094	93,259	90,345	87,625	78,688
1873	90,539	95,397	96,562	94,231	90,956	85,488
1874	90,928	91,899	91,705	94,231	90,956	87,819
1875	91,705	91,899	97,340	94,814	89,374	78,493
1876	107,054	108,025	108,803	102,197	96,757	87,431
1877	88,402	90,539	85,876	86,654	81,991	78,882
1878	79,853	79,086	73,636	75,773	74,025	69,750
1879	67,807	68,390	66,836	67,419	63,922	56,150
1880	84,128	81,602	84,711	80,436	80,825	75,579
Mean	88,763	90,577	91,659	89,660	85,130	78,577

Date.	January.	February.	March.	April.	May.	June.
1881	69,362	67,419	68,002	65,670	74,025	78,299
1882	74,996	70,722	68,390	67,419	75,385	77,328
1883	68,293	66,428	66,564	67,866	67,769	74,899
1884	68,021	64,310	62,639	59,336	66,545	68,269
1885	70,275	68,099	65,437	62,018	73,364	79,873
1886	65,554	62,348	62,484	62,018	71,324	74,549
1887	64,407	61,629	61,066	58,307	65,378	74,083
1888	56,483	50,286	51,186	51,010	61,621	76,611
1889	63,245	58,125	58,513	58,425	68,330	71,491
1890	62,468	52,687	52,563	51,398	59,573	69,883
1891	51,486	53,446	50,868	53,940	61,532	60,632
1892	54,188	47,867	44,689	47,372	56,394	62,751
1893	50,198	46,701	46,949	51,257	61,427	70,819
1894	58,073	56,588	54,647	61,550	78,712	82,949
1895	71,596	69,195	65,646	65,276	72,373	79,224
1896	69,826	69,720	66,207	67,637	78,531	85,787
1897	73,870	68,449	68,732	71,133	77,189	83,545
1898	64,335	60,345	57,644	61,793	65,024	72,351
1899	72,770	70,069	68,127	67,950	83,134	91,080
1900	82,428	80,839	77,661	77,838	81,369	80,486
1901	81,136	81,369	76,955	79,427	86,136	85,253
1902	79,939	76,955	75,542	76,778	82,781	87,549
Mean	67,180	63,799	62,296	62,973	71,269	76,714

Date.	July.	August.	September.	October.	November.	December.
1881	82,379	80,825	84,322	93,454	91,316	85,099
1882	83,934	86,071	84,711	83,156	81,796	76,551
1883	78,319	86,615	80,087	77,289	74,977	69,925
1884	72,704	73,578	74,880	76,531	78,629	73,500
1885	83,331	87,742	83,040	79,484	78,085	72,334
1886	77,755	80,592	77,794	78,338	77,094	68,623
1887	81,272	78,999	76,259	79,640	75,191	67,322
1888	79,383	79,294	77,864	77,582	74,068	68,083
1889	76,222	76,346	76,222	73,627	68,348	61,497
1890	76,258	74,651	72,691	77,211	69,036	63,669
1891	62,610	62,821	61,656	62,645	60,720	56,042
1892	65,222	65,417	66,441	64,516	59,626	54,647
1893	74,263	75,746	73,450	72,408	71,438	61,921
1894	85,386	85,545	83,214	83,956	82,208	76,893
1895	83,391	83,708	86,728	88,829	79,630	75,957
1896	88,100	88,401	86,035	78,531	79,043	77,913
1897	87,571	90,325	87,394	83,563	81,727	73,057
1898	78,318	80,296	82,715	79,979	82,781	81,192
1899	94,611	97,259	100,437	94,611	95,317	92,492
1900	85,253	88,784	97,436	101,155	100,084	93,198
1901	91,786	95,670	93,552	94,611	93,728	87,019
1902	91,609	91,256	91,963	90,192	90,727	85,783
Mean	80,894	82,270	81,768	81,423	79,344	73,760

Mean discharge from 1860 to 1902 = 77,345 S-F. Mean discharge from November, 1882, to October, 1898, inclusive, = 69,954 S-F.

TABLE VII.—*Showing, in s-f, the mean monthly discharge of St. Clair River.*

Date.	January.	February.	March.	April.	May.	June.
1860	197,369	177,333	185,135	200,713	230,216	253,439
1861	181,359	163,038	170,840	190,802	231,169	256,904
1862	189,936	170,662	174,080	194,232	229,834	247,271
1863	188,411	166,469	170,649	188,133	222,782	241,043
1864	177,547	157,701	162,834	182,796	219,542	230,726
1865	157,153	139,785	148,158	173,648	205,247	217,244
1866	155,437	131,780	137,866	162,593	194,574	207,563
1867	163,442	145,312	153,876	175,554	208,297	225,827
1868	155,056	135,211	152,304	167,548	201,435	214,139
1869	151,244	133,495	133,673	156,875	191,715	208,400
1870	167,826	150,459	161,310	185,465	220,495	238,772
1871	181,931	161,323	177,892	197,854	233,075	249,941
1872	162,299	139,404	142,440	160,162	195,336	218,678
1873	154,865	135,211	141,678	165,642	203,722	224,846
1874	176,213	159,798	167,599	180,890	210,393	234,569
1875	165,539	145,312	151,208	170,979	206,200	230,216
1876	176,594	157,130	164,740	186,227	226,213	248,117
1877	190,317	171,043	174,842	192,517	224,307	246,128
1878	182,693	160,370	168,743	183,559	219,733	238,505
1879	172,591	148,934	153,304	170,026	201,054	195,878
1880	163,442	143,216	148,158	164,499	200,673	221,699
Mean	171,965	152,047	159,111	178,605	213,143	230,948

Date.	July.	August.	September.	October.	November.	December.
1860	258,672	257,162	254,195	245,165	242,285	230,329
1861	262,574	265,565	264,617	259,841	250,646	224,611
1862	249,020	251,510	247,400	258,926	252,038	213,365
1863	239,306	240,257	239,201	234,941	237,059	197,164
1864	234,935	233,816	225,938	212,471	208,724	193,543
1865	230,543	231,797	228,503	223,697	209,897	196,973
1866	214,505	218,357	214,316	211,073	210,308	191,256
1867	231,884	232,301	227,324	220,133	210,317	186,300
1868	215,282	209,264	204,206	200,927	200,120	199,833
1869	217,592	226,244	225,125	217,925	218,051	206,694
1870	241,781	239,468	245,726	236,738	227,120	198,689
1871	251,012	243,365	235,091	225,449	220,580	191,256
1872	224,570	220,979	219,659	215,519	213,125	208,981
1873	229,844	230,507	228,254	231,665	231,191	202,692
1874	237,527	234,986	232,070	226,121	211,235	207,457
1875	233,237	233,246	237,500	233,417	232,622	228,994
1876	261,665	262,529	266,828	257,786	254,105	217,749
1877	248,918	246,914	241,253	237,407	233,264	211,459
1878	237,755	235,571	230,924	234,719	233,552	195,639
1879	214,820	212,699	212,957	207,593	207,791	201,167
1880	230,318	228,965	228,026	218,990	217,262	216,605
Mean	236,465	235,976	233,767	229,071	225,300	205,841

Date.	January.	February.	March.	April.	May.	June.
1881	165,539	153,889	159,213	175,744	210,393	225,296
1882	180,596	157,130	164,931	185,274	217,064	223,175
1883	176,403	156,367	162,263	178,603	218,017	237,467
1884	192,223	170,281	176,176	198,235	230,978	244,715
1885	190,508	169,709	174,842	193,089	229,263	254,105
1886	194,320	176,571	185,325	207,003	241,842	272,435
1887	186,505	171,043	180,179	194,614	226,976	247,550
1888	168,970	148,171	156,545	175,363	212,299	240,131
1889	167,254	146,647	151,398	166,214	197,433	214,400
1890	158,296	136,926	141,678	160,496	194,955	205,535
1891	153,531	132,352	136,913	159,353	192,477	201,560
1892	142,095	121,869	128,145	145,820	176,848	185,414
1893	140,380	120,344	127,002	150,394	190,952	219,056
1894	147,813	128,924	136,913	157,447	193,621	209,771
1895	144,001	122,631	127,955	146,011	177,801	189,065
1896	127,419	110,623	113,850	130,572	166,746	177,251
1897	134,281	113,482	121,284	143,914	183,328	194,561
1898	138,283	120,344	129,861	155,350	186,187	193,496
1899	138,664	116,913	124,905	144,295	183,138	198,785
1900	141,333	122,440	128,145	146,582	177,991	187,070
1901	148,957	127,205	132,148	157,256	189,809	206,615
1902	143,811	120,916	124,333	144,867	177,420	192,395
Mean	158,235	138,399	144,727	164,386	198,888	214,539

TABLE VII.—*Showing, in s—f, the mean monthly discharge of St. Clair River*—Continued.

Date.	July.	August.	September.	October.	November.	December.
1881	229,625	224,780	224,342	237,245	240,230	213,365
1882	227,525	229,883	228,425	235,766	229,631	228,994
1883	243,263	252,329	248,555	242,876	254,975	218,511
1884	246,869	247,553	240,890	250,850	244,439	227,470
1885	257,993	261,656	260,570	257,705	251,246	222,895
1886	266,309	262,772	258,740	256,799	252,794	204,216
1887	250,550	245,987	237,830	235,574	226,259	203,073
1888	236,162	239,372	232,424	226,589	222,305	190,112
1889	221,576	221,990	219,359	212,540	204,740	190,493
1890	213,920	218,168	212,435	208,466	201,506	174,864
1891	201,371	199,601	194,870	186,809	179,504	178,295
1892	192,589	198,965	194,535	194,777	189,440	181,916
1893	207,800	205,844	199,667	196,436	192,869	181,916
1894	214,568	208,151	203,636	199,370	196,511	159,235
1895	186,932	184,259	181,490	177,851	168,356	165,906
1896	176,567	175,097	174,053	168,515	171,401	174,292
1897	198,737	199,508	194,510	187,883	186,479	195,830
1898	196,274	194,759	192,494	185,531	183,413	178,867
1899	206,600	204,305	202,385	192,410	189,500	186,681
1900	191,765	194,240	199,400	200,030	202,190	178,676
1901	209,585	212,215	202,070	199,955	196,175	178,676
1902	189,680	193,700	190,085	179,720	181,760	168,635
Mean	216,648	217,052	217,853	210,623	207,533	191,042

Mean discharge from 1860 to 1892 = 197,820 S–F. Mean discharge from November, 1882, to October, 1898, inclusive, = 191,980 S–F.

TABLE VIII.—*Showing, in s–f, the mean monthly discharge of Niagara River.*

Date.	January.	February.	March.	April.	May.	June.
1860	233,748	225,661	234,646	250,370	255,087	254,413
1861	219,147	212,858	222,741	246,102	255,760	257,333
1862	237,566	231,052	234,197	254,413	259,804	259,804
1863	238,240	244,754	243,406	246,102	250,145	247,000
1864	207,467	210,836	215,553	226,784	242,508	241,385
1865	205,670	192,642	199,830	216,003	229,031	228,581
1866	200,504	196,910	205,670	218,698	223,640	229,480
1867	213,083	203,649	214,880	222,067	233,748	240,711
1868	192,418	183,882	197,135	215,778	225,886	234,646
1869	197,584	196,012	206,793	213,532	225,886	234,646
1870	225,437	230,602	225,437	240,037	244,754	244,080
1871	215,553	208,141	218,249	229,031	235,095	235,769
1872	196,012	190,621	188,599	193,091	202,975	211,286
1873	186,577	186,802	188,374	217,126	232,175	233,972
1874	229,031	230,154	230,828	234,646	236,668	238,240
1875	195,787	191,968	195,113	204,098	214,655	224,314
1876	213,532	226,111	240,711	252,391	259,579	262,050
1877	222,292	218,698	213,532	223,191	228,806	230,603
1878	223,864	227,009	229,929	239,363	245,203	245,203
1879	216,901	213,757	214,430	222,517	225,886	227,908
1880	217,575	218,474	221,618	225,212	231,277	233,747
Mean	213,714	211,362	216,270	228,122	236,122	238,436

Date.	July.	August.	September.	October.	November.	December.
1860	248,573	244,979	237,342	230,603	228,581	224,988
1861	251,717	252,616	248,573	243,406	242,957	237,791
1862	259,130	250,594	243,631	235,095	227,458	228,132
1863	244,305	242,508	233,748	223,864	214,655	213,981
1864	235,545	229,480	224,538	217,575	213,757	215,329
1865	227,683	225,886	224,988	218,249	209,713	206,569
1866	231,951	226,335	224,988	224,763	219,372	219,597
1867	236,443	229,480	220,720	213,083	201,852	196,910
1868	233,972	222,292	216,227	206,119	202,526	197,808
1869	240,936	238,689	232,625	222,517	212,184	220,046
1870	244,979	243,856	238,240	229,705	222,966	220,270
1871	235,320	230,603	226,784	211,735	207,692	197,808
1872	211,061	210,387	205,221	201,402	193,990	188,824
1873	233,523	232,175	223,191	216,452	211,960	220,270
1874	238,914	235,320	224,988	215,104	205,670	200,953
1875	227,234	227,009	223,864	212,858	209,489	214,430
1876	259,579	252,840	249,022	237,117	238,914	231,277
1877	235,994	232,849	231,052	222,067	220,270	222,067
1878	245,203	239,812	236,892	229,031	224,538	226,335
1879	228,581	223,640	216,227	211,061	200,504	206,344
1880	235,769	230,378	225,212	215,329	213,532	205,895
Mean	238,401	234,368	228,956	220,816	215,361	218,839

TABLE VIII.—*Showing, in s-f, the mean monthly discharge of Niagara River*—Continued.

Date.	January.	February.	March.	April.	May.	June.
1881	196,685	199,156	206,344	222,067	231,052	236,443
1882	230,378	230,378	240,486	245,428	249,920	253,290
1883	211,735	216,452	220,720	223,415	233,748	249,471
1884	223,191	229,031	233,298	245,653	251,717	253,514
1885	211,510	206,793	203,649	222,067	238,465	249,920
1886	240,262	223,864	219,597	239,363	246,102	248,348
1887	219,147	228,806	246,326	247,450	251,493	251,942
1888	211,510	205,446	207,692	221,843	227,458	230,378
1889	212,409	208,815	205,221	213,083	217,926	226,784
1890	213,981	220,495	223,191	234,197	241,834	250,145
1891	212,409	211,960	222,292	219,372	215,329	218,474
1892	189,947	185,230	186,128	198,707	216,677	233,748
1893	186,802	188,599	193,541	209,940	228,806	233,074
1894	201,852	199,156	199,830	208,815	217,575	222,292
1895	188,150	182,984	183,208	188,824	193,765	195,787
1896	182,085	180,288	179,165	189,273	197,809	203,873
1897	185,005	189,498	197,809	210,163	217,575	219,821
1898	196,236	200,729	206,569	219,597	222,966	223,640
1899	198,033	193,316	201,627	208,366	215,329	218,024
1900	191,070	195,787	203,649	210,612	214,206	216,003
1901	190,845	182,984	180,288	189,498	199,156	203,424
1902	184,781	174,673	181,860	193,990	202,301	208,141
Mean	203,546	206,477	206,477	216,442	224,110	229,388

Date.	July.	August.	September.	October.	November.	December.
1881	235,320	228,132	220,270	219,147	215,104	219,821
1882	251,717	248,573	242,508	232,400	225,212	213,757
1883	253,964	252,616	245,203	238,465	229,929	230,588
1884	248,573	244,979	235,320	227,908	217,926	215,553
1885	249,022	249,246	245,877	243,631	240,936	239,796
1886	247,899	243,406	237,791	232,625	226,111	224,314
1887	246,776	239,588	234,422	221,169	215,104	215,553
1888	233,748	231,502	221,618	213,307	214,655	211,510
1889	231,277	224,314	215,553	206,119	200,055	205,895
1890	241,609	231,726	227,458	223,191	222,517	217,350
1891	216,227	210,163	206,119	197,584	187,701	189,273
1892	236,443	228,581	221,394	208,815	201,402	195,338
1893	226,784	219,147	210,612	202,750	193,765	195,562
1894	221,843	213,532	209,713	202,526	197,135	195,562
1895	193,316	191,519	189,273	178,491	176,245	179,839
1896	201,178	205,895	198,707	193,316	185,005	185,679
1897	219,597	216,003	209,713	198,707	195,787	195,113
1898	218,698	214,206	205,670	201,178	198,482	194,664
1899	211,735	207,467	202,076	196,685	196,910	190,621
1900	213,083	212,409	205,221	199,830	193,990	193,091
1901	203,424	200,504	198,932	190,396	186,577	187,251
1902	222,067	221,618	213,981	211,960	205,895	201,402
Mean	228,377	224,324	218,086	210,918	205,711	204,455

Mean discharge from 1860 to 1902 = 219,843 s-f. Mean discharge from November, 1882, to October, 1898, inclusive = 216,468 s-f.

TABLE IX.—*Showing, in s-f, the mean monthly discharge of St. Lawrence River.*

Date.	January.	February.	March.	April.	May.	June.
1860	249,985	245,805	257,019	268,910	278,101	292,012
1861	246,602	242,055	263,118	279,854	307,726	317,000
1862	262,792	245,102	267,021	301,488	325,759	319,061
1863	254,576	248,384	260,434	290,035	303,862	307,726
1864	243,945	232,912	244,577	269,674	298,453	306,181
1865	262,067	257,762	271,901	285,709	293,300	294,331
1866	222,922	216,502	225,549	247,531	252,083	249,507
1867	234,762	227,052	253,359	287,235	308,499	315,455
1868	199,967	196,342	210,911	236,332	254,659	265,478
1869	217,123	213,454	227,501	250,839	270,888	276,556
1870	266,416	261,980	272,632	308,361	327,562	319,319
1871	237,420	226,348	240,674	266,365	280,420	278,874
1872	205,282	193,997	197,982	219,025	224,776	233,277
1873	195,133	190,950	201,641	260,257	277,328	275,268
1874	244,428	246,508	269,949	278,836	281,708	284,026
1875	205,282	190,950	205,057	234,295	244,097	248,219
1876	219,297	228,223	250,920	286,726	305,150	310,818
1877	233,312	220,018	232,614	260,257	265,221	262,645
1878	223,405	221,660	247,749	264,838	276,813	276,556
1879	255,543	239,476	245,553	266,622	272,176	272,949
1880	219,539	219,550	236,771	251,603	258,523	264,706
Mean	233,324	226,906	242,044	267,371	281,290	284,284

Date.	July.	August.	September.	October.	November.	December.
1860	298,453	284,026	273,722	268,827	270,888	270,373
1861	311,333	304,893	292,785	298,195	298,453	293,043
1862	321,637	309,787	293,558	279,389	270,373	267,539
1863	297,164	285,314	275,525	270,631	265,994	266,251
1864	297,937	286,087	272,434	266,509	265,736	268,312
1865	290,467	274,752	259,038	253,371	246,931	242,809
1866	273,207	270,631	268,312	264,963	258,781	256,720
1867	305,923	289,694	276,813	260,069	241,005	221,427
1868	262,387	254,916	250,022	234,823	230,959	235,338
1869	284,799	286,345	281,708	279,389	269,085	273,464
1870	311,075	302,317	284,542	276,040	261,357	254,916
1871	274,752	263,418	254,659	241,778	231,216	223,230
1872	234,823	230,701	223,230	219,109	217,821	209,062
1873	274,237	267,024	256,204	244,612	241,263	246,158
1874	282,738	276,813	260,326	250,022	235,338	226,579
1875	248,991	245,385	239,975	232,762	227,867	223,230
1876	312,621	300,771	285,057	276,298	267,024	262,387
1877	263,675	256,720	245,642	234,565	232,247	235,596
1878	275,525	273,464	266,766	260,069	256,977	277,844
1879	268,827	259,811	248,991	237,657	227,610	228,383
1880	264,963	253,886	244,354	233,792	232,762	228,383
Mean	283,597	275,084	264,460	256,327	249,985	248,145

Date.	January.	February.	March.	April.	May.	June.
1881	205,524	199,154	223,353	243,713	251,310	256,977
1882	229,446	226,582	250,432	269,674	277,844	290.982
1883	219,539	214,392	228,964	252,112	271,919	289,951
1884	248,294	249,556	276,292	303,779	307,984	305,408
1885	239,353	225,879	228,232	255,421	279,132	288,663
1886	274,632	268,075	282,391	310,397	319,577	314,424
1887	240,079	250,494	273,121	290,290	308,242	307,211
1888	222,438	212,517	227,012	252,876	257,750	258,780
1889	226,788	223,300	236,527	252,876	259,811	267,797
1890	242,012	242,992	261,462	278,328	290,982	307,211
1891	240,561	239,476	262,386	285,963	283,769	272,949
1892	199,967	193,294	202,325	227,933	232,247	246,673
1893	208,666	199,858	219,694	248,294	281,193	286,860
1894	225,339	222,832	239,210	250,839	258,523	272,176
1895	199,483	192,122	197,494	220,042	225,806	222,715
1896	182,810	189,543	201,397	233,786	236,884	234,565
1897	184,743	177,822	197,250	222,079	236,111	241,778
1898	203,108	207,359	225,549	246,513	253,628	254,916
1899	211,323	202,671	217,010	240,659	250,022	253,371
1900	199,967	201,264	216,513	243,458	251,310	249,249
1901	204,074	196,575	198,857	239,132	249,507	252,083
1902	199,725	192,591	219,694	237,604	239,975	241,263
Mean	218,539	214,924	231,144	254,807	264,705	268,909

TABLE IX.—*Showing, in s-f, the mean monthly discharge of St. Lawrence River*—Continued.

Date.	July.	August.	September.	October.	November.	December.
1881	258,781	250,537	236,111	230,443	230,443	230,443
1882	290,724	282,223	272,434	259,296	248,476	241,005
1883	303,605	298,968	286,602	275,268	269,343	265,736
1884	299,998	294,073	282,996	272,176	259,296	255,432
1885	292,270	288,406	282,738	277,844	279,132	283,511
1886	304,120	292,785	283,511	276,040	264,706	262,387
1887	299,998	286,860	271,146	261,099	252,083	245,127
1888	260,326	257,750	247,703	238,429	236,626	236,369
1889	272,692	266,251	251,825	240,490	230,186	244,870
1890	302,832	285,572	276,556	268,055	270,115	264,706
1891	265,736	254,401	243,324	226,837	211,380	210,608
1892	259,811	257,750	252,598	241,263	234,308	230,959
1893	280,162	266,251	259,296	245,900	235,338	231,474
1894	267,024	252,083	238,945	232,504	224,003	214,987
1895	215,244	208,804	200,045	191,287	184,847	185,619
1896	227,867	224,261	211,896	205,971	199,273	199,273
1897	241,521	241,263	228,382	212,153	210,608	212,153
1898	247,703	238,687	228,125	221,685	222,973	223,230
1899	249,507	237,657	224,776	213,699	211,123	209,319
1900	246,931	239,717	228,898	218,851	214,729	221,685
1901	251,310	242,036	231,474	221,427	216,533	214,987
1902	241,263	----------	----------	----------	----------	----------
Mean	267,247	260,301	249,494	239,558	233,596	232,565

Mean discharge from 1860 to 1902=251,930 s-f. Mean discharge from November 1882 to October 1898 inclusive=248,518 s-f.

TABLE X.—*Showing, in inches, the mean monthly rainfall in the basin of Lake Superior.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	1.43	1.47
1883	1.49	0.99	0.68	1.25	2.48	4.32	3.95	1.77	2.23	2.72	2.93	2.12
1884	.83	1.75	1.14	2.57	3.22	1.21	2.74	5.22	5.25	4.52	1.42	3.62
1885	1.32	.61	1.36	1.48	1.98	3.52	3.04	2.16	2.04	1.63	2.65	1.89
1886	1.71	1.75	1.27	1.76	1.43	2.71	1.50	2.08	3.66	2.84	2.04	1.05
1887	.89	1.24	.50	1.45	1.98	1.93	5.20	1.02	1.18	2.58	1.49	1.41
1888	1.88	1.12	1.85	2.01	2.67	3.79	1.85	2.84	2.72	2.03	2.00	.86
1889	1.87	1.39	1.56	3.35	2.22	2.10	4.35	3.74	3.61	1.09	1.22	2.47
1890	2.30	2.34	1.02	1.67	2.36	3.09	4.19	3.02	2.45	2.03	.69	.84
1891	1.03	1.62	1.70	.87	.58	1.46	3.17	3.12	2.70	2.63	1.68	2.03
1892	1.33	1.03	1.11	1.64	2.49	1.82	2.75	3.53	1.79	2.18	2.01	1.39
1893	1.58	2.00	1.55	2.66	2.13	3.22	2.62	2.74	2.58	3.03	2.03	2.74
1894	1.70	.64	2.28	2.08	3.78	1.88	2.02	2.05	2.75	4.51	2.39	1.63
1895	2.27	1.03	.67	1.82	2.87	3.21	2.22	2.28	4.68	1.81	1.63	1.88
1896	1.76	.96	1.23	3.38	4.60	1.78	1.62	2.62	1.59	3.08	4.23	.66
1897	2.58	1.35	1.89	1.60	2.50	3.16	5.68	2.55	2.03	2.51	1.74	1.58
1898	1.13	1.77	1.55	.77	3.37	4.28	2.42	2.48	2.43	2.76	------	------
Mean	1.60	1.35	1.33	1.90	2.54	2.72	3.08	2.70	2.73	2.62	1.97	1.73

TABLE XI.—*Showing, in inches, the mean monthly rainfall in the basin of Lakes Huron and Michigan.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	2.82	2.50
1883	2.31	3.28	1.10	1.65	5.33	5.86	6.11	1.64	2.66	3.19	3.63	1.87
1884	2.67	3.13	2.28	2.02	2.57	2.73	3.10	2.47	3.50	4.44	2.16	4.54
1885	3.02	1.74	1.30	2.25	2.58	3.61	2.87	4.69	3.04	3.09	3.06	3.24
1886	4.00	2.20	3.21	2.23	1.86	2.67	1.43	3.94	4.62	2.67	2.66	2.07
1887	3.26	3.86	1.10	1.51	1.63	2.11	3.10	1.73	2.52	3.22	1.78	3.78
1888	2.20	1.81	2.84	2.20	3.11	1.63	1.77	2.59	3.11	2.43	2.64	2.00
1889	2.42	2.05	.65	1.58	3.59	4.46	2.73	1.52	3.18	1.22	2.84	3.23
1890	3.71	2.30	2.00	2.73	3.62	3.94	3.07	3.17	1.97	3.68	2.01	1.58
1891	2.44	2.92	2.83	2.04	.80	1.97	2.34	3.91	1.80	1.74	5.10	2.49
1892	2.77	1.95	1.15	1.89	4.17	5.01	3.05	3.16	2.81	2.13	2.64	2.39
1893	2.78	2.22	2.16	3.88	2.93	2.44	3.32	2.01	2.84	3.65	3.11	4.24
1894	2.57	1.52	2.60	1.82	4.82	2.70	1.45	1.16	3.72	3.26	2.56	2.52
1895	3.79	1.64	1.19	1.45	2.90	1.49	1.21	2.96	3.06	1.40	2.97	3.84
1896	1.90	1.53	1.57	2.84	3.06	2.34	2.26	3.49	4.45	1.71	3.72	1.33
1897	3.70	1.33	2.98	3.18	3.06	2.60	3.47	2.11	1.34	2.36	2.60	2.38
1898	2.79	2.26	3.12	1.79	2.58	3.77	1.59	3.38	2.46	2.34	------	------
Mean	2.90	2.23	2.01	2.19	3.04	3.08	2.68	2.75	2.94	2.66	2.89	2.75

TABLE XII.—*Showing, in inches, the mean monthly rainfall in the basin of Lakes St. Clair and Erie.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	2.56	2.23
1883	1.66	3.94	1.45	2.03	6.03	4.96	5.13	2.02	2.57	3.21	3.01	2.31
1884	2.15	3.93	2.61	1.51	2.72	2.59	3.61	1.79	2.37	2.46	1.96	2.81
1885	2.70	1.38	.96	2.64	3.91	4.78	2.89	5.34	2.56	3.79	3.21	2.50
1886	3.39	1.92	2.52	2.61	2.84	2.47	1.91	2.97	4.45	1.49	3.77	3.12
1887	1.97	6.11	1.94	1.73	2.49	3.03	1.43	2.33	2.71	2.25	3.12	2.85
1888	2.54	1.76	2.88	2.25	2.85	2.36	2.90	2.55	2.22	2.87	3.48	1.85
1889	2.99	1.66	1.60	2.15	4.51	3.43	2.71	1.15	2.77	1.44	3.41	3.42
1890	4.11	3.10	2.89	3.31	5.33	3.88	1.38	3.44	3.49	4.89	2.98	1.43
1891	2.14	4.20	3.13	2.02	1.61	2.92	2.76	3.21	1.96	2.07	5.55	2.20
1892	2.26	2.76	2.42	2.55	7.87	5.98	3.43	2.88	3.48	1.10	3.08	1.63
1893	2.79	4.58	2.13	4.75	4.11	2.89	2.42	2.07	1.50	3.80	3.16	3.23
1894	1.92	2.75	1.81	2.08	5.52	2.62	1.63	.67	4.01	3.21	1.88	2.28
1895	3.15	.71	1.43	1.66	2.29	1.50	2.09	2.74	2.32	1.27	4.62	4.63
1896	1.73	2.60	2.60	2.98	2.57	3.79	5.58	3.54	4.50	1.33	2.51	1.65
1897	2.51	1.66	3.62	2.59	3.83	2.77	4.04	2.82	.78	1.21	5.28	2.09
1898	3.75	2.47	4.11	1.87	3.21	2.91	2.99	2.91	3.31	2.40	------	------
Mean	2.61	2.84	2.38	2.42	3.85	3.31	2.93	2.65	2.81	2.42	3.35	2.51

TABLE XIII.—*Showing, in inches, the mean monthly rainfall in the basin of Lake Ontario.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	1.96	2.37
1883	2.00	2.94	1.84	2.01	5.60	4.90	4.59	2.37	2.64	2.30	2.18	1.83
1884	3.67	3.06	3.11	1.13	3.64	3.46	3.45	2.59	2.22	2.43	2.28	3.08
1885	2.82	1.79	.89	2.34	2.74	4.06	3.18	5.52	3.12	4.09	2.39	2.86
1886	3.79	2.02	3.05	3.20	2.31	2.33	3.35	2.77	3.77	1.93	4.74	1.97
1887	2.75	4.20	1.83	1.82	1.64	2.77	3.78	2.77	1.74	2.30	2.00	2.73
1888	2.47	1.84	2.75	2.85	2.35	3.39	1.88	4.13	3.40	4.29	3.59	2.70
1889	3.91	2.21	1.62	3.16	3.39	6.79	5.17	2.02	3.10	3.47	5.20	3.41
1890	3.98	3.29	3.09	2.80	6.26	4.24	2.76	4.81	6.68	4.90	2.93	2.98
1891	3.06	3.65	3.25	1.85	1.19	2.78	4.32	4.24	1.62	2.96	2.86	4.03
1892	3.72	2.28	2.93	1.09	5.61	5.52	4.28	5.70	2.16	1.89	3.65	1.46
1893	2.03	3.56	2.13	3.53	5.81	2.50	3.33	5.65	3.24	2.31	2.05	3.62
1894	2.94	2.61	1.65	3.55	6.77	3.23	2.62	1.43	4.97	4.22	2.07	2.45
1895	2.84	1.77	1.47	1.86	2.58	2.57	2.60	3.89	2.29	1.41	3.54	3.94
1896	2.16	4.47	3.96	1.07	2.59	2.89	4.86	2.50	4.36	2.66	2.68	1.41
1897	2.27	1.53	3.07	2.45	3.35	2.96	5.13	2.35	2.03	.80	4.26	3.04
1898	3.71	2.02	2.19	2.51	3.58	3.00	2.30	5.57	3.20	4.92	------	------
Mean	3.01	2.70	2.42	2.32	3.71	3.58	3.60	3.68	3.16	2.93	3.02	2.74

TABLE XIV.—*Showing, in degrees F., the mean monthly temperature in the basin of Lake Superior.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	29.1	14
1883	0.5	7.2	13.6	34.6	42.5	56.4	60.6	59	50.7	39.1	26.3	12.3
1884	2.3	2.7	16.6	33.9	47	59.8	58.5	60.3	55.1	43.4	26.2	10.8
1885	0.0	1.2	11.9	34	45.8	55.6	63	56.5	52.4	38.9	29.1	17.1
1886	2.6	8.8	21.2	38.1	49.2	56	63.5	61.6	51.2	45.3	24.5	7.2
1887	−1.1	5.2	16.7	34.3	53	58.6	64.8	59	52	37.4	26.3	15.1
1888	− .4	6.8	10.9	31.2	40.8	55.7	60.7	57.9	49.7	37.7	27.7	19.7
1889	15.4	4.1	28.5	38.4	46.5	55.1	61.6	61.8	53	38.5	27.6	22.6
1890	9	11.6	16.7	37.4	41.3	59.1	63	57.6	51.8	42.3	30.3	18
1891	15.3	8.5	16.2	38	46.9	56.1	57.7	59.9	58.6	42.4	23.3	23.3
1892	6.6	13.9	20.9	32.6	43.6	55.9	64.9	62.9	56	44.4	23.6	11.6
1893	1.1	4	16.6	30	45	61.2	63.3	61.3	52.7	41.9	26.2	8.5
1894	8.7	10	26	37.9	46.6	61.3	64.3	60.6	56.6	43.2	23.1	21.9
1895	5.3	7.9	18	40.2	50	57	59.8	60.7	55.3	37.9	25.5	17.7
1896	10.5	13.9	15.7	37.8	52.6	59.3	62.7	61.8	50.7	39.3	19.6	17.9
1897	8.7	13.2	17.8	36.8	46.6	53.2	65.5	60.1	59.7	45.6	24.6	13.1
1898	15.3	14.6	26.7	37.3	48	55.9	62.7	60.7	56.6	40.4	------	------
Mean	6.2	8.3	18.4	35.7	46.6	57.2	62.3	60.1	53.9	41.1	25.8	15.7

TABLE XV.—*Showing, in degrees F., the mean monthly temperature in the basin of Lakes Huron and Michigan.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882											35.8	22.8
1883	13	16.8	21.5	38.3	46.2	59.4	63.8	62.2	54.1	44.4	35.4	23.8
1884	13	18.3	25.7	38.3	50.7	62	62.5	63	61.6	49.6	33	22.4
1885	11.9	8.8	17.5	37.6	48.3	58.7	66	60.1	56.9	43.9	35.7	24.7
1886	15	18.3	27.6	42	50.5	59.2	65.3	64.8	58.2	49.6	31.6	17.3
1887	12.1	18.5	22.9	39	56.1	62.6	70.3	63.4	56	42.5	32.6	24.7
1888	10.2	16.4	20.6	36.9	46.2	61.7	64.8	62.3	53.3	41.9	34.7	26.5
1889	23.4	12.6	32.1	41.5	50.7	56.8	65	64.5	57.8	42	34.1	32.5
1890	23.8	24.4	23	41.9	46.9	64.8	66.5	61.7	54.2	46.5	43.4	23.9
1891	23.1	21.6	24.9	41.6	49.4	61.6	61.8	64.2	62.6	46.9	31	31.6
1892	15.3	22.9	25.4	38.7	48.9	60.7	66.9	65.5	58.7	47.8	30.8	20.3
1893	9.5	15.3	26	38	48.6	63.9	67.3	64.2	57.2	47.9	33.2	19.9
1894	21.8	17.5	34.7	42.5	50.1	65.3	68.2	62.1	60.8	47.5	29.9	28.2
1895	14.5	13.2	23.6	42.2	53.9	64.3	64.1	65.6	62.2	41.4	32.3	25.3
1896	20.6	20.7	23.5	45.2	58.8	62.7	66.5	66.5	54.6	43.7	37.5	26.1
1897	19.1	22.7	27.4	40.1	49.6	58.8	69.7	63.3	62.7	51.3	33.5	21.6
1898	22.4	21.6	33.8	40.4	52	62.6	67.6	65.5	61.8	46.7		
Mean	16.8	18.1	25.6	40.2	50.4	61.6	66	63.8	58.3	45.8	33.9	24.5

TABLE XVI.—*Showing, in degrees F., the mean monthly temperature in the basin of Lakes St. Clair and Erie.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882											40.4	28.8
1883	21.8	26.4	28.5	43.9	53.1	66.6	70.3	67.2	59	50.7	43.2	32.6
1884	19.5	29	33.1	43.1	57	68.5	68.5	68.5	67.3	54.9	39	30.3
1885	21.5	16.4	24.6	43.5	55.5	64.5	72.3	65.6	61.5	49.6	40.7	30.8
1886	22.2	24.9	33.2	47.8	56.8	65	69.5	68.7	63.7	53.1	37.6	23.7
1887	22.8	28.4	29.8	43.6	61.6	67.8	75.8	68.5	60.2	48.1	38.6	30.1
1888	19.5	25.2	28.2	42.7	54.3	67	69.5	68.1	59.9	45.8	40.8	31.5
1889	30.8	20.3	35.8	45.4	57.4	63.9	71.6	67.5	62.5	46.5	40.6	39.9
1890	35	34	30.6	45.8	54.2	69.9	71.1	66.7	60.5	51.6	46.7	28.1
1891	29.4	32	31.3	47.2	53.9	67.4	66.8	69	67.1	51	38.3	37.1
1892	22.1	29.7	30	44.3	54.7	69.1	71	70.5	63.2	51.6	36.9	27.2
1893	16.2	23.6	33.1	44.3	54.3	68.8	72	69.1	62.1	52.9	38.9	29
1894	31.2	24.5	40.8	46.5	56.5	68.9	72.9	68.7	66.2	53.1	36.3	33.3
1895	21.3	18.2	29.1	46.9	58.7	69.9	69.1	70.5	66.5	45.6	39.6	31.6
1896	25.9	26.2	28.4	51.1	63.8	66.9	71.2	69.9	60.3	47.8	42.6	30.8
1897	23.5	28.2	35.8	45.3	54.4	63.8	73.9	67.2	65.1	55.8	40.2	30
1898	29.7	27.7	42	44.3	57.9	68.6	73.1	71.6	66.8	53.1		
Mean	24.5	25.9	32.1	45.3	56.5	67.3	71.1	68.6	63.2	50.7	40	30.9

TABLE XVII.—*Showing, in degrees F., the mean monthly temperature in the basin of Lake Ontario.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882											34.7	25.2
1883	17.9	22.2	22.3	40.2	50.4	65	65.6	63.2	54.3	46	38.5	26.7
1884	16.8	23.4	26.9	39	52.3	65	63.6	65.6	62	48.5	35.3	26
1885	18.5	11.7	18.1	38.6	52.5	60.9	68.5	62.7	56.8	46.6	37.8	27
1886	18.7	20.6	29.5	45.5	53.5	61.7	66	64.8	59.5	49.2	35.1	20.7
1887	19	23.4	25.1	39.6	59.5	64.1	73.1	65	56.1	44.5	35.2	27.1
1888	14.7	21.4	22.9	38	51.8	64	65.9	65.5	56.1	42.9	37.5	28
1889	27.2	16.5	31.4	43.1	55.5	61.7	67.9	63.8	59.6	41.9	38.1	33.9
1890	29.1	27.6	26.9	42.6	51.4	65.2	67.6	64.3	57.8	47.1	36	19.5
1891	24.1	27	29.1	43.9	51.3	63.7	63	65.4	62.2	46.5	35.9	33.6
1892	20.2	24.3	25.1	40.7	51.2	65	67.4	66.5	58.7	46.9	34.3	22.7
1893	13.3	18.6	28	39.1	51.9	65.8	67.1	65.8	56.3	49.1	35.8	23.8
1894	26	19.2	36.4	43.3	53.7	64.9	69	64.3	62.1	50	33	28.7
1895	18.9	14.9	24.4	42.4	56.3	66.9	64.9	66	61.6	42.6	37.8	29.4
1896	19.4	21.4	22.8	46.3	58.8	62.6	68.3	67.1	57.6	44.5	40.8	25.4
1897	21.3	23.2	31	43	52.6	59.2	70.7	63.8	59.2	50	36.4	27
1898	22.8	24.7	38.5	41	54.5	64.9	70.7	68.6	62.4	50		
Mean	20.5	21.3	27.4	41.6	53.6	63.8	67.4	65.2	58.9	46.6	36.4	26.5

TABLE XVIII.—*Showing, in per cent, the mean monthly relative humidity in the basin of Lake Superior.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	76.4	76.5
1883	79.1	73.8	70.2	68.2	66	69.5	68	70.1	71.1	74.7	73.1	76.8
1884	76.9	76.6	73.7	70.3	65.5	70.7	72.1	74.8	72.9	68.7	75.3	80.3
1885	72	72.5	75	71.3	68.3	73.7	74	74.7	69.7	73.7	85	83.7
1886	86.7	82.7	76.3	76.3	64.7	71.7	70.4	76	74	72.3	73.7	76.7
1887	76.3	77.7	75.3	75	70	76.7	77.3	77	72.3	70.7	73	81
1888	78.7	82	80.7	77.3	70.7	75.7	76.2	76.5	77.5	79.2	82.2	82.5
1889	84.2	84	79.2	74.7	70.5	73	76	75.2	77.7	77.5	80	81.7
1890	82.2	80.5	77	68.5	71	75.2	74	76	77.2	78.2	76.8	78.2
1891	82	81.8	80.8	74.5	59.5	69.8	71.8	74	75.8	72.5	82.2	84
1892	81	84	79.5	75.5	72.2	75.5	70.8	77.8	79.8	77	82.8	80.5
1893	80.2	74.8	76	79.2	69.8	71.2	74	73	76.2	80.8	81	86
1894	88	84	84.5	78.8	70.2	69.8	67.2	74	72.8	82	84.2	85
1895	85	83.8	74.5	71.5	70.2	75	74.8	73.2	74	73	82.2	82.5
1896	86	80.8	76.8	78.5	74.5	70	71.5	72.2	77.5	79.2	87.8	85
1897	86	87.2	84.2	71.2	67.2	73.8	79	77	76.8	82.5	85	86.5
1898	86.8	86.2	80.8	68	72.2	78.8	75	78.8	75.5	82	------	------
Mean	81.9	80.8	77.8	73.7	68.9	73.1	73.2	75	75	76.5	80	81.7

TABLE XIX.—*Showing, in per cent, the mean monthly relative humidity in the basin of Lakes Huron and Michigan.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	78.4	80.9
1883	79.2	77.8	71.4	67.7	71.4	76.6	75.1	72.4	75.2	74.9	75.1	76.4
1884	75.2	78.2	75.3	69	69.5	73.8	73.5	73.7	74.1	73.4	79	83.4
1885	78	79.8	77	75.8	74	73.6	76.8	79.4	76	80.8	81	83.6
1886	84.2	80.6	80.6	79.4	73.6	75.8	75.2	77	76.8	75	75.8	80.5
1887	81	83.3	76.3	70.2	69.5	74.2	70.8	72.5	75	73.2	75.5	84.7
1888	82.8	82.5	79.8	71.3	74.7	71.8	73.3	75.7	77.6	78.8	80.7	80.4
1889	84.3	81.8	76.6	72	70.3	81.1	74.8	72.3	76.7	76	82.7	81.8
1890	84.1	84.1	78.8	70.3	72.4	74.4	70.7	74.6	77.1	82.1	77.1	79
1891	84.4	82.7	80.1	74.1	60.6	72.9	70.3	74.7	74.6	74.3	79.6	77.8
1892	80.6	82.8	76.9	70	75.7	82.3	72.7	76.3	78.1	75.1	80.3	82.3
1893	83.8	81	78.8	76	71	73.3	72.6	71	74.3	76.3	78.9	83.4
1894	82.6	80	78.1	75.1	76	70.3	65.3	70.4	75.6	78.7	76.6	78.7
1895	81.1	80.1	73.4	70.4	69	66.7	66.4	71.4	71.3	68	77.6	81.3
1896	82.6	79.7	76.3	76.7	70.8	69.8	72	74.7	80.6	78.4	83.4	83.1
1897	82.3	81.1	81.3	76.7	71	72.4	74.7	74.6	73.6	77.4	78.7	82.6
1898	83.1	83.7	79.7	70.7	74.1	75.7	70	79	76.9	82.6	------	------
Mean	81.8	81.2	77.5	72.8	71.5	74	72.1	74.3	75.8	76.5	78.8	81.2

TABLE XX.—*Showing, in per cent, the mean monthly relative humidity in the basin of Lakes St. Clair and Erie.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	72.4	78.5
1883	78.2	77.3	70	65.6	68	70.6	70.5	67.3	71.9	72.8	68.5	73.5
1884	77.8	80.7	75.2	68.7	67.3	70.1	68.2	68.9	71	71.9	76	78.1
1885	76.1	76.5	75.2	72.8	73.2	72.5	74.6	79.8	73.3	78.5	80	79.3
1886	81.8	77.8	78.6	74.3	72.3	72.3	69.6	72.8	70.6	72.8	74	79.8
1887	78.1	82	76.5	68.8	68	72.6	68.1	66.3	72.3	69.8	71.5	77.7
1888	81	77.5	75.1	64.7	67.6	68.8	68.6	70.6	74.6	74.5	75.3	75.8
1889	80	80.5	74.3	70.3	65.5	76	71.8	67.1	74	70.8	80.5	77.1
1890	79.8	79.8	75.6	68.1	73.3	72.5	65.8	70.8	77.5	80.6	74.3	76.8
1891	82.5	77.1	77.6	72.6	65.6	71.6	67.6	70.1	71.6	69.5	73.6	72.5
1892	79.1	82.3	77	68.5	77.6	77.7	68.8	72.3	74.8	71.7	78.8	80.3
1893	82.7	82.3	76	74.8	71.8	71.5	66	66	69.6	73.3	72.6	79.8
1894	76.8	78	70.8	70	73.1	67.8	61.3	65	72.3	74.5	74.1	77.5
1895	83	80.3	74.7	69.3	66.1	65.8	62.7	67.1	68.3	65.1	76.3	81.1
1896	82.7	81	78.1	75.1	68.5	70.6	73.5	73.3	76.6	72.1	76	80.1
1897	82.5	80.6	77.5	72.6	71.8	67.8	71.1	71.1	65.5	69.1	77.8	79.8
1898	79.5	79.8	75.5	65.5	71.8	70.5	67.8	75.3	72.5	75.3	------	------
Mean	80.1	79.6	75.4	70.1	70.1	71.1	68.5	70.2	72.3	72.6	75.1	77.9

TABLE XXI.—*Showing, in per cent, the mean monthly relative humidity in the basin of Lake Ontario.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	74.8	80.2
1883	78.4	78.8	74.7	70.5	72	75.6	75	71.8	74.2	72.6	69.1	71.4
1884	76.3	79.9	77	73.8	72.3	70.7	75.5	70.4	74.6	75.5	78.5	82.4
1885	80.3	83.3	80.3	74.7	76	77.3	80	81	77.7	81.3	81.3	83
1886	87.7	82.7	81	75	74.3	73.3	74	75.7	75.3	79.3	79	84
1887	83.3	82.7	78	67	67.7	78.7	75	70.3	69.7	73.7	71.3	81.7
1888	83.7	78	80.3	69.7	71	70	66.3	69.7	76	77	78.3	79
1889	82	83	76.7	69.7	70.3	78.3	75.7	72.7	76	77	80.7	78
1890	81.3	81.3	78	66.7	73.3	73.3	67.7	72.3	78.3	79	77.7	80.3
1891	82.7	79	75.3	71.3	67.3	67.3	67.3	73.3	74	69.7	70.3	72.7
1892	79.7	81.3	78	66	76.3	77	70.3	75.3	71	72.3	77.3	78
1893	81.7	80	75.3	72.7	73	72	70.7	72.3	76.3	75.3	72.7	81.7
1894	78.3	79.3	73.7	67.3	71.3	75	70.7	66.7	74.3	75.7	74.3	79
1895	80	78.3	73.7	69.3	66	69	72	71.3	67.7	67.3	73.7	75.3
1896	80.7	81.7	75.7	74.3	66.7	65.7	71	70	72.7	72.7	74.3	76
1897	79	75.7	75	67.3	69.3	67.3	74.3	71.3	67.3	69	77.3	79.3
1898	79.3	78.7	71.3	65	73.3	74	67	74.3	75	76	------	------
Mean	80.9	80.2	76.5	70	71.2	72.8	72	72.4	73.7	74.6	75.7	78.9

TABLE XXII.—*Showing, in miles per hour, the mean monthly velocity of wind in the basin of Lake Superior.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	9.4	9.8
1883	11.2	9.9	11.1	10.3	10.4	8	7.5	7.2	7.7	8.3	9.9	10.2
1884	8.9	8.6	7.4	9.3	8.7	8.2	7.2	8.5	9.7	11.1	10	9.4
1885	7.6	7.2	8.5	9.4	8.4	7.9	6.8	8.1	9.2	8.7	9.2	9.8
1886	10.3	11.6	9.4	9.3	8.6	7	7.2	7.4	8.9	9.5	10.6	9
1887	8.3	8.3	8.6	10.2	9.2	8.1	7.1	7.6	8.8	10	8.9	9.6
1888	8.9	8.9	9.7	9.7	8.2	8.9	6.6	6.8	8.4	7.5	7.3	8.5
1889	7.8	8.8	8.7	9	8.8	7.3	7.1	7.8	9.1	7.9	8	8.5
1890	8.5	10.3	9.4	9.8	9.2	7.5	7.9	8.3	8.9	8.3	9.2	9.2
1891	7.2	9.2	8.3	9.5	9.8	8.6	7.6	6.9	9.2	9.5	9.2	10.5
1892	9	8.7	9	11.3	9.3	7.6	7.1	7.4	9.2	9.6	10.1	7.9
1893	8.9	9.5	10.3	11.3	8.9	8.9	7.7	8.4	9.9	9.8	9.4	9.6
1894	9	9.5	10.7	9.4	10.3	8.2	7.7	7.2	9.6	10	10.6	9.3
1895	9.5	10.2	12.1	10.1	9.8	8.7	8.4	9	11.1	11	8.8	10.4
1896	9.5	10.3	11.5	11	10.7	8.5	7.8	8.6	10.4	9.7	10.8	9.2
1897	10.7	9.6	10.2	11.3	9.7	8.4	7.9	8.6	9.7	9.8	10.3	9.2
1898	9.2	10.8	11.5	10	9.6	9	8.8	7.9	9.6	10.7	------	------
Mean	9	9.4	9.8	10	9.3	8.2	7.5	7.8	9.3	9.5	9.5	9.4

TABLE XXIII.—*Showing, in miles per hour, the mean monthly velocity of wind in the basin of Lakes Huron and Michigan.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	------	------	------	------	------	------	------	------	------	------	9.5	10.2
1883	11	11.2	10.6	11	11.1	9.2	8.8	8.1	8.4	10	12.5	10.8
1884	11.8	9.8	9.9	10.7	9.6	6.9	7.6	8.1	9.2	10.4	9.6	10.7
1885	12	8.7	9.6	10.9	9.4	8.5	7.5	7.5	9.1	8.9	10.5	11.2
1886	10.7	11.6	10.4	9.3	8.9	7.6	7.5	7.9	9.4	9.2	11.9	9.8
1887	12.1	11.6	10.5	11.4	8.3	7.5	6.8	7.6	9.2	11.8	11.9	11.4
1888	10.4	10.1	11.5	11.1	9.3	9.2	7.2	8.5	7.3	9.9	9.6	11.4
1889	10.2	10.4	9.7	10.1	10.9	7.5	7.6	7.7	8.3	8.7	9.9	10.8
1890	10.6	12.2	12.2	12	11.6	8.7	9.9	9	9.9	9.7	11.5	12.1
1891	9.6	12.9	12.7	11.2	10.9	9.1	9.5	8.3	9.4	11	12.3	14.4
1892	12	10.8	11.2	13.8	11.4	8.9	8.3	8.4	9.6	10.7	11.7	10.1
1893	10.6	12.8	12.6	14.6	11.1	9.1	9	8.8	11.2	11.8	11.9	12.9
1894	11.8	13.4	13.7	10.4	12.2	9	8.9	8.6	10	10.6	12.4	12.5
1895	12.2	12.4	13.1	10.6	10.6	8.7	9	8.4	11.6	12	11.2	11.5
1896	10.7	12.6	12.3	12.2	11.4	8.5	8.7	9.1	10.4	10.1	13.1	9.8
1897	11.9	11.1	11.9	13.8	10.3	9	8.3	8.9	8.8	9.9	12.6	11.2
1898	11.3	12.2	11.1	11.3	10.4	9.3	8.5	8.3	9.4	11.8	------	------
Mean	11.2	11.5	11.4	11.5	10.4	8.5	8.3	8.3	9.4	10.4	11.4	11.3

TABLE XXIV.—*Showing, in miles per hour, the mean monthly velocity of wind in the basin of Lakes St. Clair and Erie.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	10	11.5
1883	11.6	11.7	11.5	10	10.3	7.6	7.5	8.1	8.7	9.7	13.2	11.3
1884	11.4	10.2	9.8	9.8	8.8	7.4	8.1	7.9	9	10.4	11.6	12.6
1885	13.2	10.2	11.2	10.9	9.1	8.9	8.3	8.5	9	9.4	11.4	12.9
1886	11.2	12.8	10.8	10.3	8.3	7.7	7	7.7	9	9.1	12.7	10.4
1887	14.2	13	10.9	11.2	7.3	7.1	8	7	8.2	10.7	12.1	10.6
1888	10.7	10.4	12	9.8	9.3	8.6	7.5	8.5	8.6	10.7	11	12.3
1889	12	12.1	9.6	9.6	9.7	8.9	7.3	7.7	9.3	9.8	10.2	12
1890	12.8	11.6	11.7	10.2	8.6	6.8	8.2	7.8	8	8.8	10.8	11.8
1891	9.1	12.4	11.6	9.9	8.5	7.5	8.7	7.7	7.9	10.4	12.6	13.1
1892	11.8	10.3	10.4	12.2	10.7	9.2	7.9	8.7	10	11	12.2	11.1
1893	11.7	13.4	12.7	14.2	10.6	9.3	9.2	8.4	11	11.3	13.1	14.1
1894	12.1	13.2	12.9	9.8	10.2	8.5	9	7.8	9.8	10.3	14.1	13.2
1895	13.2	13.1	12.5	10.2	9.7	8.1	8.5	8.1	10	12.8	11	12.6
1896	10.3	13.8	13.4	11.9	11.3	8.7	9.6	9.2	10.3	10.5	14.5	11.9
1897	13.9	12.1	13.8	12.6	10.2	9.1	8.9	9.2	8.8	10.8	14	12.7
1898	13.4	12.5	11.5	11.5	9.4	9.2	8.7	8.7	10.4	12	-----	-----
Mean	12	12	11.6	10.9	9.5	8.3	8.3	8.2	9.2	10.5	12.1	12.1

TABLE XXV.—*Showing, in miles per hour, the mean monthly velocity of wind in the basin of Lake Ontario.*

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1882	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	9.5	12.8
1883	13.1	15	12.4	9.1	11	7.5	8.1	8	7.7	12.4	13.4	12.2
1884	14.6	12.5	11.1	9.3	10.1	7.2	8.7	8.2	9.7	11.7	13.2	14.2
1885	16.2	12.7	13	11.1	8.9	9.8	8	8.2	9.5	9.1	11.3	14
1886	12.8	13.5	12	9.9	9.3	8.3	7.3	8.3	9.8	10.8	15.2	12.5
1887	15.5	15.2	12.8	11.9	7.5	7	8.2	7.8	9.1	11.3	13.6	11.9
1888	13.6	12.1	13.5	11	9.4	8.7	7.3	8.1	8.4	11.5	11.8	13.5
1889	12.9	12.9	9.2	8.9	9.8	9.1	8.1	8.3	9.1	9.7	10.9	14.1
1890	13.8	13.2	12	10.7	8.9	7.9	9.1	8.9	7.8	9.6	12.1	13
1891	10.8	13.7	12	10.8	9.2	7.2	9.1	7.4	7.9	9.7	13	13.3
1892	11.6	10.2	12.1	11.5	9.2	8.7	7.8	7.6	9.7	10.1	11.4	11.9
1893	12.1	13.2	12.4	11.9	9.2	7.6	8.7	7.4	9.4	10.5	12.7	12.7
1894	12.6	12.9	11.9	8.7	8.8	8.3	8.2	7.8	8.4	10	13.1	12.9
1895	13.7	14.5	11.6	8.8	8.7	6.5	7.9	7.5	8.6	12.2	10.3	11.8
1896	9.9	14.2	14.9	10.9	11.2	8.8	9	9	9.8	9.9	13.6	12.6
1897	14.7	13.5	14.1	12	10.2	9	8.5	8.7	8.9	10.2	14.4	13.1
1898	12.9	11.9	11.8	11.2	9.1	9.8	8.4	9.3	10.1	11.2	-----	-----
Mean	13.2	13.2	12.3	10.5	9.4	8.2	8.3	8.1	9	10.6	12.5	12.9

F F F 3.

REPORT OF MAJ. JAMES G. WARREN, CORPS OF ENGINEERS.

Manitowoc, Wis.—Alleged shoal or reef situated about 4 miles south of Manitowoc Harbor, and 2½ miles offshore, upon which the master of steamer *Tuscarora* reported striking, and over which he reported the depth of water to not exceed 13 or 14 feet.

A preliminary examination was made, and report submitted under date of July 5, 1902, with recommendation that a survey be made.

In compliance with instructions dated July 10, 1902, a survey was made and report with tracing, showing the location and soundings thereon, was submitted under date of April 13, 1903.

Racine, Wis.—Reef off Wind Point, near Racine Harbor, Wisconsin, upon which it was reported the steamer *Saranac* struck April 14, 1903.

In compliance with instructions contained in first indorsement Office Chief of Engineers, U. S. Army, April 25, 1903, an investigation was made and report dated May 7, 1903, submitted with recommendation that an examination or survey be made as soon as the weather conditions would admit.

Under date of June 18, 1903, I submitted a report that under my direction the reef was definitely located and plainly marked, and that a survey was considered to be necessary. Not having the facilities for making the required survey, a thorough survey of the reef and its vicinity was immediately undertaken by Maj. W. L. Fisk, Corps of Engineers, U. S. Army, and is still in progress.

Money statement.

July 1, 1902, balance unexpended	$309.86
June 30, 1903, amount expended during fiscal year	234.04
June 30, 1903, balance deposited to credit of Treasurer United States	75.82

APPENDIX G G G.

IMPROVEMENT OF YELLOWSTONE NATIONAL PARK, INCLUDING THE CONSTRUCTION, REPAIR, AND MAINTENANCE OF ROADS AND BRIDGES.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

UNITED STATES ENGINEER OFFICE,
Yellowstone Park, Wyo., July 17, 1903.

GENERAL: I have the honor to transmit herewith report upon improvement of Yellowstone National Park for the fiscal year ending June 30, 1903.

Very respectfully, your obedient servant,

H. M. CHITTENDEN,
Captain, Corps of Engineers,
U. S. Army.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

IMPROVEMENT OF YELLOWSTONE NATIONAL PARK.

OPERATIONS FOR SEASON OF 1902, AFTER JUNE 30.

The work in progress during the past fiscal year has all been done under the continuing appropriation act of June 28, 1902. This act gave the sum of $250,000 for the fiscal year with a guaranty of a like sum in each of the two following years. The second appropriation became available March 3, 1903, and at the close of the fiscal year about one-half of it had been expended. The operations for the year have been as follows:

MAMMOTH HOT SPRINGS.

The situation at Mammoth Hot Springs has for many years been one of great inconvenience and discomfort on account of the character of the soil. This consisted entirely of deposit from the Hot Springs, largely carbonate of lime. In its natural state it did not sustain vegetation, and it was so soft that it ground up into a fine dust under travel, which was blown about in every direction by the winds. It has long been desired to have this ground irrigated, covered with soil, and turned into lawn, but the necessary work was so great that the means for accomplishing it have never before been available. Under the

present appropriation and through the assistance of the Quartermaster's Department of the Army in its improvement of Fort Yellowstone, which is situated upon these grounds, the work was undertaken and is now practically completed. It is embraced under the following headings: Roads and walks, grading and clearing of grounds, water supply and irrigation system, buildings, electric light and power plant.

The roads around the plateau have been so laid out as to serve as well as possible the convenience of all parties concerned. They have been given a width of 20 feet, have been laid out to true grades, and surfaced to a depth of 6 to 10 inches with gravel from Capitol Hill. This gravel packs in time to a very substantial roadbed, but requires liberal sprinkling to keep down the dust. The length of roadway constructed is 9,600 feet.

Along most of the roads cement sidewalks have been built with a width of 4 feet. The materials used in the construction of these sidewalks have been Atlas cement and the gravel and sand taken from the quarry on Capitol Hill. The gravel and sand were used in their natural condition and no effort was made to screen or separate them into definite proportions. The material has given excellent results, and the walks constructed from it are as fine as can be found in the United States. The depth of the mixture averaged about 6 inches. Where the walks crossed the hollows in the ground, a liberal allowance of bowlders were put on the ground at the base and built up with weak concrete. The walks have now passed through twelve months, including one winter season, and there is scarcely a crack to be found in the entire length constructed. This length amounts to 10,044 feet.

Crossings of the roads were also built of the cement, rounded on the edges to facilitate the passage of wheels, and with longitudinal creases to prevent horses from slipping. This last expedient has been only partially successful, and it is found where walks cross on turns in the roads so that the push on the walk by the horses' feet is sidewise there is danger of slipping and falling, and it will probably be found necessary to chip the surface of these walks so as to make them rough.

The entire grounds embraced in the plateau have been cleared of all débris and buildings, including an old deer corral, the residence and photographic studio of Mr. F. J. Haynes, and a barn of the Hotel Association. The ground was everywhere plowed up by means of what is called a rooter plow, that is, a plow with a very heavy beam and cutting edge, but with no moldboard. It was drawn by 6 to 10 horses and was very effective in cutting through the lime deposit. The ground was then thoroughly harrowed with a disk harrow, and such of the pieces of formation as could not be crushed in this way were picked up and hauled away. The surface was then covered to a depth of about 2 inches with a rich loam hauled from the depressions in the neighboring hills. During the previous two years manure and other refuse had been hauled upon the grounds from the various barns in the vicinity. After the grounds had been smoothed up and harrowed as much as possible, they were sown with a mixture of clover and bluegrass seed, about the time of the last snowfall during the past spring. The entire ground was then thoroughly rolled with a 10-ton steam roller. It is believed that this roller was too heavy for the purpose and that it packed the ground more than it should have been for the proper germination of the seed.

A supply of irrigation water being absolutely essential to the creation of a lawn, this matter was given very careful attention. A 6-inch

pipe line leads from the 10-inch water main, presently to be described, into a circular irrigation fountain, where it is released under a pressure of about 40 pounds per square inch in such a way as to give an overflow without any violent ebullition. This fountain is situated at the highest point of the grounds, so that the water can flow from it over the entire plateau. Ditches are led from this point along both sides of all the roads with frequent pipe culverts passing under them and concrete diverting sluices for the effective control of the flow. The result is that strong streams of pure water are flowing in every direction over the grounds in such a way that they can be easily dammed and turned out on the grounds wherever desired. To supplement these open ditches, a pipe system is laid from the mains to all parts of the grounds, giving about fifty attachments for sprinkling hose. These occur at sufficiently small intervals, so that the entire ground can be reached in this way. It is expected to use this hose to cover those portions of the ground which it is difficult to reach with open irrigation. The supply of water is ample for the purpose and there should be no difficulty in creating an abundant lawn in two or three years. The overflow from the system passes off the grounds over a steep bluff and descends to the main road below the hill, where it is used for filling the road sprinklers.

The water supply for the buildings at Mammoth Hot Springs, including Fort Yellowstone, the engineer department, and all other buildings located upon the plateau, comes from two sources. One is an old reservoir built in the gulch back of Liberty Cap, having a capacity of about 100,000 gallons. This is a closed concrete reservoir, covered with a wooden roof, and the water is conveyed to it in a tile pipe buried beneath the ground. The main supply comes from Glen Creek, a branch of the Gardiner River, and is stored in an open reservoir of about 2,000,000 gallons capacity, located a little above the old military post. The dam of this reservoir is built of concrete, as are also the intake and overflow. The distance from the reservoir to the point where water is taken from Glen Creek is something over 2 miles, and the water is brought over this distance in an open ditch. Along this ditch are four flumes, by which the water is dropped to different levels in order to reach more practicable ground in the construction of the ditch. The supply main leading from this reservoir is a 10-inch cast-iron pipe; that from the old reservoir, a 4-inch pipe. The two meet at right angles near the irrigation fountain above referred to, and where they cross a commodious valve house has been made with a system of valves which gives perfect control of the entire water supply in such a way that either supply can be used for domestic purposes or for irrigation, or both can be used together. Before reaching the valve house, however, one 6-inch main is taken out from the 10-inch pipe. This leads to Fort Yellowstone, as does also a 4-inch main from the valve house, while a third main, 4-inch, leads to the hotel buildings, the engineer department, and transportation buildings. Two cross mains connect these three mains on the grounds at Fort Yellowstone, so that every point of the system has practically three sources from which it may receive water in case of any sudden demand for fire or other purposes. Numerous fire hydrants and gate valves are established and the whole system is under thorough control.

The water from the old reservoir is hard, but is believed to be very pure water; that from the new reservoir is soft, but is more liable to contamination from surface flow during heavy rains or melting snow.

For the lighting of the grounds and the buildings at Mammoth Hot

Springs an electric-light plant has been constructed. The power is water, derived from the same source as the domestic and irrigation supply. In order that this supply may never be taxed beyond its limit, a ditch was built leading from the Gardiner River, about 7 miles from Mammoth Hot Springs, across a low divide into Glen Creek. By means of this ditch any possible future demand can be abundantly supplied. This ditch also furnishes a supply for sprinkling the road from the fourth to the sixth milepost. Leading from the new reservoir, both at the head and the foot, a ditch is constructed to convey water to the head of the penstock. As this flume had to pass for a portion of its distance under a public highway and over a stretch of low ground, a concrete flume was used for this distance. It passes under the road by means of an invert and over the low ground in an aqueduct on pillars 12 feet apart. The arrangement is perfectly satisfactory from a practical point of view and gives a very pleasing effect as a structure. From the end of this aqueduct an open ditch is carried around to the east base of Capitol Hill, from which is laid a 16-inch penstock to the site of the power house, 900 feet distant and 240 feet below. The penstock is made of steel, one-eighth of an inch thick, with flanged joints.

The entire plant in the power house is in duplicate, and consists of the following units: One 4-foot Pelton impulse water wheel; one 50 K. W. Westinghouse generator, with the necessary switch board, exciters, governor, and other appurtenances. The wheels can develop jointly about 175 horsepower, and the generators, under a 25 per cent overload, about 150 horsepower. The foundations of the wheels and generators are concrete monoliths resting upon the rock formation of the hot springs. A neat and commodious power house shelters the plant and has quarters in the second story for the engineer in charge. The generators are of the alternating type, 2,200 volts. The distance from the power house to the center of distribution is about 2,400 feet, the extreme point being about 4,000 feet. The lighting system consists exclusively of incandescent lights. For the purpose of lighting the grounds a separate series system has been adopted, consisting of 4 circuits of 20 lamps, each 32-candlepower, each lamp being provided with a street series shunt coil to introduce the necessary resistance in case any lamp is burned out. The lights in the buildings range from 12 to 32 candlepower. Total amount of light to be furnished at extreme load is between 1,800 and 2,000 lamps of 16-candlepower. It is not expected, however, that the average consumption will be more than one-fourth of this amount. The plant also furnishes power to a 25-horsepower motor, installed in the United States engineer shop. A telephone line connects the power house with the office of superintendent of the Park, and also the engineer in charge of the improvement work. By act of Congress, approved March 3, 1903, private parties at Mammoth Hot Springs are authorized to use electric current from this plant at actual cost of operation and a 10 per cent annual depreciation upon the original cost of the plant.

In connection with the improvement work it has been necessary to erect a number of new buildings, those previously in use being of the cheapest possible construction and practically worn-out. Among the buildings erected are the United States Engineer Office, a substantial stone and concrete structure, thoroughly built, heated with hot water and wired for electric lights, telephones, etc. The other buildings consist of a commissary and storehouse, a machine shop with quarters above for the yard force, two sheds for the storage of material, a stable,

and a bunk house for such of the force as can not be accommodated in the shop.

In connection with the laying out of the grounds, the professional services of the eminent landscape gardener, Mr. Warren H. Manning, of Boston, were gratuitously tendered. Mr. Manning made a thorough study of the grounds and embodied his recommendations in a report, which is appended hereto. So far as has been practicable, the plans of Mr. Manning have been followed, and they will probably be carried out in full in the future.

NORTH ENTRANCE TO PARK.

From its geographic situation and the fact that Mammoth Hot Springs has become the business and administrative headquarters of the Park, and the further fact that this is the only point at which railroads can approach any of the prominent natural features or large hotels of the Park, the northern entrance is the most important of any, and this importance it will probably always retain. It has been thought fitting, therefore, to provide some suitable entrance gate at this point. This was more important because the natural features of the country at this portion of the boundary are about the least interesting of any part of the Park, and the first impression of visitors upon entering the Park was very unfavorable. During the past year the Northern Pacific Railroad has extended the Park branch of its system from Cinnabar to the boundary line at Gardiner, and the time seemed particularly favorable to combine a proper entrance gate with the new station which the railroad was about to put in at the boundary. With this purpose in view, the railroad and the Government have cooperated, and the present arrangement, now practically completed, is the result. The railroad terminates in a large loop which is tangent to the Park boundary. The wagon road also terminates in a loop which is tangent to the boundary at the same point. Between these two loops is located the railroad station, with a platform on each side—one for unloading from the cars and the other for the convenience of carriages. Within the driveway loop an excavation has been made for an artificial body of water, and provision has been made for the irrigation of the grounds around it. The water supply comes from the Gardiner River, a distance of about a mile.

Crossing the neck of the driveway loop, and on the crest of a ridge about 30 feet above the level of the station grounds, a masonry arch has been constructed of columnar basalt found in the vicinity. The width of the opening is 20 feet, the height is 30 feet, and the maximum height of the structure 50 feet. Two wing walls, 12 feet high, run out laterally from the arch to a distance of 50 feet from the center, where they terminate in small towers which rise about 3 feet above the wall. From these towers and parallel to the two branches of the loop, walls 8 feet high extend to the Park boundary. Three tablets in concrete are built into the outer face of the arch, with the following inscriptions: Above the keystone, "For the Benefit and Enjoyment of the People;" on the left of the opening, "Yellowstone National Park," and on the right, "Created by Act of Congress, March 1, 1872." The corner stone of the arch was laid under Masonic auspices by President Roosevelt, on the 24th day of April, 1903. Leading from the arch across the plain, in the vicinity of the town of Gardiner, the road extends in a straight line until it strikes the Gardiner River, where a bluff crowds the road and stream together. Lines of trees have been planted along

this avenue, and they are supplied with irrigation water from the ditch already referred to. The whole effect will be to give a dignified and pleasing entrance to the Park at the point where the great majority of visitors enter it.

ROAD BETWEEN GARDINER AND MAMMOTH HOT SPRINGS.

Practically all the freight that enters the Yellowstone Park comes in by way of the Northern Pacific Railroad. The great bulk of it goes only to Mammoth Hot Springs. This freighting and the business of Fort Yellowstone, together with the tourist travel, cause this road to be used more than any other in the Park, and the use has become so great as to make extra provision for it absolutely necessary. Accordingly the road has been widened to 25 feet, all the grades have been reduced to 8 per cent, and the whole length has been provided with a surface of macadam or gravel. Vitrified clay-pipe culverts and one cast-iron culvert replace the former wooden structures. There are four crossings of the Gardiner River in this distance, and they are all built of steel, resting upon monolithic concrete abutments.

GOLDEN GATE TO CRYSTAL SPRING.

This road for a distance of about 7 miles was practically all regraded and surfaced with broken rock or good gravel.

VIRGINIA CASCADE.

The road in the vicinity of Virginia Cascade had two of the worst hills remaining on the road system, and a very short and dangerous curve at what is called the Devils Elbow. This entire stretch of dangerous road was about three-quarters of a mile long. It has been replaced by a road carved in the rock of the cliffs. About two-thirds of it is on a level grade, and the other third on a grade of 8 per cent. Besides eliminating the bad hills and dangerous curve, this road has materially added to the scenic effect of this canyon.

BLANDING HILL.

This was another of the steep and dangerous hills remaining on the road system. It has been cut out by an easier grade, not exceeding 8 per cent. The amount of new road thus built is about three-fourths of a mile.

GIBBON CANYON.

A considerable amount of work has been done in Gibbon Canyon. Two bad hills have been cut out, the total amount of new road being something over a mile. This includes one new steel bridge, with concrete abutments. The road for half a mile below Gibbon Falls has been entirely rebuilt, with a heavy retaining wall to hold the unstable slope. This work was done during the winter time, and the rock was hauled on sleds from a quarry about a quarter of a mile distant.

NATURAL BRIDGE CUT-OFF.

About 2 miles of the west end of this road was enlarged and graded to full width, and about a mile on the east end was similarly treated.

MOUNT WASHBURN ROAD.

On the Mount Washburn division two parties were at work all summer, each constructing about 5 miles of well-graded road. One party worked from the Canyon Hotel, and the other from the vicinity of Tower Falls. The work in the vicinity of Tower Falls was of a very heavy character, and was carried on mainly during the winter. It lies under a high overhanging cliff and forms a section of road of great scenic beauty.

MAMMOTH HOT SPRINGS TO MIDDLE GARDINER.

This road was nearly all graded, but owing to the necessity of moving the party to another part of the Park it has not been quite finished. Three piers of the high bridge crossing the Gardiner River have been put in.

GRAND CANYON JUNCTION.

The road in this vicinity has been nearly all graded to connect with the new high bridge over Cascade Creek. A portion of the road extending from the junction to the foot of the hill toward Norris was covered with broken stone.

EAST ROAD.

Work on this road was continued throughout the balance of the season, leaving only about 12 miles to close the gap between the eastern and western portions. Two large bridges were put in over Shoshone River, and one over Elk Creek, besides many smaller bridges. Work was resumed in March of this year, and the remaining gap is very nearly closed at the date of this report.

GENERAL REPAIRS.

The repairs, including resurfacing, have extended over a considerable part of the system. A good deal of work was done on the Yellowstone River road. Another road across the flats on both sides of the Fountain Hotel was resurfaced, together with most of the road along Firehole River. Considerable work was also done in the Upper Basin, Spring Creek Canyon, and other portions of the Continental Divide road.

SPRINKLING PLANT.

The sprinkling plant has been gradually developed and at the date of this report there are now on hand sixteen sprinklers. Tanks are in from Gardiner to Norris for filling the sprinklers, and this amount of road is being regularly sprinkled.

BRIDGES.

The material has been purchased and delivered for nine bridges, including the steel for the steel-concrete bridge on the Yellowstone River. Work is actively in progress on this bridge and the false work and forming for the arch are practically all in.

STATION HOUSE.

A new station house was built for the Superintendent at the south boundary of the Park on the southern approach.

SOUTH ROAD.

A party was kept on the south road for about two months and did a large amount of work in placing that road in better shape.

Money statement.

July 1, 1902, balance unexpended	$256,390.51
Amount appropriated by sundry civil act approved March 3, 1903	250,000.00
Amount received from United States Commission of Fish and Fisheries for sawing lumber	210.00
	506,600.51
June 30, 1903, amount expended during fiscal year	347,645.77
July 1, 1903, balance unexpended	158,954.74
July 1, 1903, outstanding liabilities	91,211.71
July 1, 1903, balance available	67,743.03
Amount (estimated) required for completion of existing project	250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1905, in addition to the balance unexpended July 1, 1903: For works of improvement and for maintenance of improvements	250,000.00

APPROPRIATIONS.

	Administration and protection.	Roads and bridges.	Total.
March 3, 1883	$16,429.97	$23,570.03	$40,000.00
July 7, 1884	16,999.98	23,000.02	40,000.00
March 3, 1885	16,790.63	23,209.37	40,000.00
July 15, 1886	934.25		934.25
August 4, 1886		20,000.00	20,000.00
March 3, 1887		20,000.00	20,000.00
October 2, 1888		25,000.00	25,000.00
March 2, 1889		50,000.00	50,000.00
August 30, 1890		75,000.00	75,000.00
March 3, 1891		75,000.00	75,000.00
August 5, 1892		45,000.00	45,000.00
March 3, 1893		30,000.00	30,000.00
August 18, 1894			30,000.00
March 2, 1895	10,565.24	89,434.76	30,000.00
June 8, 1896			5,000.00
June 11, 1896			35,000.00
June 4, 1897	6,736.74	28,263.26	35,000.00
July 7, 1898	11,356.57	28,643.43	40,000.00
March 3, 1899	5,534.64	34,465.36	40,000.00
June 6, 1900	5,000.00	55,000.00	60,000.00
March 3, 1901	5,000.00	113,000.00	118,000.00
June 28, 1902	5,000.00	250,000.00	255,000.00
March 3, 1903	5,000.00	250,000.00	255,000.00
Total	109,348.02	1,258,586.23	1,363,904.25

Abstract of contracts in force June 30, 1903, improvement of Yellowstone National Park.

Name of contractor.	Articles.	Quantity.	Rate.	Date of approval.	Date of beginning of work.	Date of expiration.
American Bridge Co.	Bridge material:	*Pounds.*				
	Bridge (*a*) for the Yellowstone River near Yanceys	57,500	3½ cents per pound.	Jan. 9, 1903		On or before May 1, 1903.
	Bridge (*b*) for the Yellowstone River near Upper Falls	53,400	4 cents per pound.	do		Do.
	Bridge (*c*) for the Gardiner River near Mammoth Hot Springs	251,700	3½ cents per pound.	do		On or before July 1, 1903.
	Bridge (*d*) for the Gardiner River near seventh milepost south of Mammoth Hot Springs.	11,600	3.45 cents per pound.	do		Do.
	Bridge (*f*) for the Firehole River one-half mile above Excelsior Geyser.	22,000	3.35 cents per pound.	do		Do.
	Bridge (*o*) for the Gibbon River near sixth milepost south of Norris.	22,000	3.35 cents per pound.	do		On or before May 1, 1903.
	Bridge (*s*) for the Nez Perce Creek	13,200	3.65 cents per pound.	do		On or before July 1, 1903.
	Bridge (*t*) for the Cascade Creek, near Grand Canyon of the Yellowstone River.	95,800	3.60 cents per pound.	do		On or before May 1, 1903.
Paul McCormick	Furnishing teams, etc.:					
	Two-horse or mule teams, with wagons, harness, and full equipment.		$2.57 per day.	Mar. 4, 1903		
	Two-horse driving teams, with full equipment except vehicles.		$3.68 per day.	do		
	Saddle horses, first class, with full equipment		$1.15 per day.	do	Jan. 1, 1903	June 30, 1905.[a]
	Saddle horses, second class, with full equipment		60 cents per day.	do		
	Pack animals, with full equipment		$1.15 per day.	do		
	Cart horses or mules, with full equipment except carts		$1.50 per day.	do		
	Hauling from Gardiner, Mont., to Mammoth Hot Springs, Wyo.		8 cents per hundredweight.	do		
	Hauling from Mammoth Hot Springs, Wyo., to points in Yellowstone National Park.		$1.47 per 100 miles per 100 pounds.	do		

[a] And may be further extended to Dec. 31, 1905, to include the annual appropriation of that year, upon approval of the Chief of Engineers.

Appendix A.

REPORT OF MR. WARREN H. MANNING UPON A PLAN FOR PARKING THE GROUNDS AT MAMMOTH HOT SPRINGS.

In the vast landscapes of the Yellowstone Park, where even in the foreground of distant views substantial roads are but shadowy lines and great buildings mere specks, it is only where people live in a conventional way and where accommodation and transportation must be provided for great crowds during a large part of the year that there is justification for such cultivated conditions as one would find in city parks and private grounds. Within such areas convenience compels a compact arrangement of the numerous buildings, yards, roads, and walks that are necessary. The whole surface is used and inspected daily by many people, all of which justifies careful attention to detail. Furthermore, the open space between buildings and the buildings as well are the foreground to wonderful landscapes in every point of view.

To visitors who have passed over the approach to the Park and through its entrance and vestibule the plateau at Mammoth Hot Springs is the first place where they can rest their bodies and adjust their minds to comprehend the scale of the wonders that are to follow. The more attractive this place is made in all respects in summer and in winter, and the longer people can be induced to stay, the better it will be for all concerned.

Existing roads and walks meet all practical requirements, and are so substantially constructed that they must be accepted. For the present only one additional walk is recommended across the lawn, in a position where it is obviously required. It is further recommended that a walk be carried on easy grades to the summit of the hill at the end of the lawn and that a straight flight of stone or cement steps be carried up the end of the ridge to a landing at the point of intersection with the proposed walk and waterway. At this point a platform sheltered from wind could be constructed, from which there would be a view over the lawn, and from this platform more steps to a platform on the end of the hill. Another walk is recommended from some point near the stables along the slope among the trees at the back of the officers' quarters to a point on the entrance road nearly opposite the power house. Such a walk will, for the most part, be so far down the slope that outbuildings and yards behind officers' quarters, and all probable extensions of them, will not be visible. From this walk a constantly-changing series of views framed in by tree foliage will be opened up toward Mount Everts and into and across the adjacent valleys, a series of vistas such as can not be secured from any other situation on or near the plateau.

Another walk is recommended from some point back of the engineer office, behind the willow thicket, and thence on an easy grade up the slope to, beyond, and above the end of the narrow-gauge terrace, making connection with the road at some point above the terraces on the formation. As such a walk will look into back yards in some places, it will be an incentive to maintain orderly conditions in such yards. All such yards will, however, be soon shut out from such a walk by proposed plantations. It will be desirable to establish upon such walks substantial seats at important view points, with a table or block in front of them, or a block alone having arrows and inscriptions pointing to and designating important landscape features. Such blocks could be made at first of wood with the arrow and inscription burned in with the platinum needle equipment used for photography.

It is further suggested that a ditch be carried around the hill at the end of the plateau lawn to supply water to passages down the slope of this hill on the edge of the lawn, in order that water-side plants may be established.

Of more immediate importance than all other recommendations is the proposed planting, the purpose of which is to frame in turf areas and provide an agreeable zone of transition from the finished conditions of the plateau to the roughness and at times aridness of natural conditions beyond; to so establish foliage about and in all artificial structures that they may grow out of foliage, be made a part of the landscape, and have their obtrusiveness so subdued as to make them in all respects agreeable features, as a part of the foreground of the fine distant views, without shutting out such views. The plantations are located and the selection of varieties is made for accomplishing this purpose primarily. In this selection it is recognized that the associations attached to familiar plants make it desirable that they be used in the immediate vicinity of the houses. In all other plantations the native plants of the Park are used almost exclusively because of their beauty, appropriateness, and availability. If these plants are labeled with names and with statement of habitat it will be of interest to visitors.

WARREN H. MANNING,
For MANNING BROTHERS,
1101–1104 Tremont Building, Boston, Mass.

NOTES ON PLANTING.

1. In the plantations of about 36,000 Douglas fir the smaller areas near the proposed steps should be planted first. The larger areas can be planted with seed. When the proposed flume is carried along the slope, seeded areas below this flume can be given water. Where water is not available as well as in irrigated areas, a mulching of old manure will be of material assistance in retaining moisture, shading young seedlings, and preventing surface wash.

2. Against tall fences, the blank walls of buildings, and in similar positions elsewhere, but out of the line of important views, young plants of Carolina poplars or other rapid-growing trees will quickly shut out fences, yards, and bare walls. Such plantations from which trees can be transplanted in a year or two for other purposes will serve as nursery beds.

3. At corners of officers' quarters where there is a blank wall with high outside chimney, a group of three or four Lombardy poplars should be planted 3 or 4 feet apart to produce a towering mass of foliage.

4. The groups and belts of rapid-growing trees against bare fences and walls should be faced down with tall and low shrubs that will grow in the partial shade of the trees, and that will connect the tree foliage with the turf and also screen the walls when trees lose their lower branches.

5. Upon the steep slopes of the hill, between groups of fir, the surface should ultimately be covered with a mat of low-nature shrubs, in which the most attractive and successful species as developed by the work of this season should predominate, with others added to give variety at different seasons. Herbs should also be used in quantities among the shrubs.

6. A place is provided here for such species of shrubs and herbs as require a constant supply of water. The sides of the flumes that convey water to these waterways can also be utilized for similar plants.

7. In the arrangement of high shrubs at the points indicated—that is, against walls having windows high up and in the edges of turf areas—the varieties that retain the lower branches should be used next to turf.

8. Large shrubs and small trees should be placed against blank walls at corners of buildings and against fences, with medium and low shrubs under low windows and against the turf.

9. The width of beds here will be governed by the size of plants to be included, a wide space being required for large plants and narrower spaces for smaller plants. Such high-growing vines as the Virginia creeper should be trained up the corners of buildings to gables and chimneys, the smaller-growing wild white clematis to piazza roofs and on fences, and the still more delicate wild blue clematis to low piazza railings and posts.

10. It is desirable that the crater holes be surrounded with a belt of shrubbery so thick and so prickly as to prevent persons from approaching too near the edges except at designated and protected points. The matrimony vine and shepardia will not only serve this purpose, but will, with their gray-green foliage and pendant branches, harmonize admirably with the gray color of the exposed formation and festoon gracefully over its abrubt edges.

11. In beds connected with the fringe of gray-green foliage around the crater holes, masses of shrubs similar in color will be appropriate.

12. In the dense shade of low, overhanging branches of the native evergreen trees on the plateau, grass will not grow. Such surfaces should be covered with evergreen ground-covering plants that thrive in shade, without trimming off the lower branches.

13. Trees should be planted at intervals of 40 feet on the edges of the parade grounds and on the opposite side of the street next to the officers' quarters. Such trees should all be of one variety, that will not grow so high as to shut out the view of Mount Everts from the hotel side of the plateau, and they should be trimmed to stems 8 feet high and to a single leader, in order that they may be uniform in outline. The trees for this purpose should be especially selected from nursery rows. They should be protected from browsing animals by a band of heavy chicken-netting wire extending the full length of the trunk, cut long enough to lap and to provide for expansion of trunk and held in place by twisting the cut ends loosely in the mesh, the band to be hung by a wire from a branch above.

14. In grouping the shrubs and small trees of these plantations the species with a tendency to lose their lower branches should be used in the center of beds and the low-growing species, or those that retain lower branches, on the outside next to turf. At a later date refinement of detail and additional variety may be secured by the use of herbs. In the work of this season in these beds and elsewhere a few reliable and easily transplanted varieties used in large quantities will be better than many varieties used in small quantities.

15. Unless young red cedars can be found in places where a good ball of earth can be retained on the roots, and in quantities large enough to make collecting economical, it will be best to sow the seed for this plantation in its place. Seed can probably be collected now in the Park.

Vines.—Vines should be used freely for the following purposes: To cover walls, fences, or buildings where the planting space is too narrow to allow the use of trees and shrubs; on similar structures in yards where quadrupeds are allowed free range. In such places the young plants and the stems of old vines should be protected from browsing by a band of heavy chicken netting, through the meshes of which the main stems of the vines should be allowed to stray in such a manner that the wire will not cut the stems as they grow.

At the angles of tall buildings vines that grow high and fast should be used and trained to make festoons of foliage along eaves, gables, and on dormers and chimneys. On piazzas and low posts more slender vines, having delicate foliage and attractive flowers, are more suitable.

Existing ground cover.—It is desirable to maintain and encourage the existing growth of sage brush, native grasses, and other herbs on portions of the hill that are to be kept open in the line of views, because it will not grow so high as to interfere with views and because it will be of interest to visitors who use the pro-

posed paths. Attention to the existing growth to develop its best features, and at a later date the introduction of other species that are found in like situations, will add to its interest.

Labeling.—If the native plants in and near the plateau are labeled it will add much to the interest of visitors. This can be done with stake labels, as in nurseries.

Planting.—Shrubs are not to be placed in single holes dug in turf, but in beds from which all grass has been removed. They should be planted with branches touching to protect each other, shade out weeds and prevent evaporation. A deep mulching of manure should be added to the surface after planting.

Collecting.—A ball of earth should be retained in collecting plants, when practicable. In any event, all possible care should be used to save roots in digging and in protecting them from drying between digging and planting. If plants have very poor roots when dry, throw away.

Trimming.—Vigorous plants with good roots need no trimming. When it seems necessary to trim, cut to surface of ground or remove whole branches instead of cutting the ends of branches.

Approximate estimates of quantity.

	Number.
1. Douglas fir, 3 feet apart, 150–3300–3828–1889–1056–330–200–200–50–13200	35,953
2. Carolina poplar, 10 feet apart, 10–16–30–25–10–1–1–1–1	105
3. Lombardy poplar, 3 feet apart, 10–50–3–3–3–3–50	122
4. Shrubs, low, medium, and high and small trees, 3 feet apart, such as birch, willow, alder, elder, maple, 330–350–200–150	1,030
5. Low shrubs and herbs, 2 feet apart, such as buck brush, ceanothus, spiræa, betulæfolia, amelanchia, asters, gaillandias, etc	11,250
6. Shrubs and herbs, including such attractive natives as require water for best development, to be worked out later.	
7. High shrubs, 4 feet apart, such as birch, elder, maple, eleagnus, dogwood, 120–300–100–30	550
8. Shrubs, low, medium. and high, and herbs averaging 2 feet apart, such as wild roses, ceanothus, syringa (Philadelphus), buck birch, spiræa, rubus, lonicera, holadiscus, such as roses in small numbers as crimson rambler, rugosa, multiflora, wichariana, sweet briars, Japanese barbarry, lilacs, including common, white, Japanese tree, Persian, Pekinensis, native herb, and such cultivated varieties as pæony, hollyhock, phlox, London pride, dieleytra, golden glow cone flower, etc. (1,600 feet of bed, 6 feet wide, plants averaging 2 feet)	24,000
9. Matrimony vine (Lycium) with Shepherdia, 3 feet apart, 10–60–100–100–100–50	420
10. Shepherdia canadensis, eleagnus argentia, and other grayish leaved shrubs, such as sage brush and grease wood sparingly, 3 feet apart, 200–100–100–100–200	700
11. Ceanothus, Oregon grape, 2 feet apart, 200–100–500	800
12. Box elder, 40 feet apart, 30–30–30	90
13. Native shrubs, large, medium, and small, and small trees, averaging 3 feet apart, such as cratægus, mountain ash, comus vitrinnas, Philadelphus, holadiscus, betula, salix, amelanchia, prunus, maple, sanibucus, rebes, rubus, rosa, symphoricarpus, loincea (2,100 feet, averaging 12 feet wide)	2,800

		Number.
14. Red cedars—		
Vines (about 100 buildings 6 each, 2 large buildings and inclosures, 50 each)		750
Virginia creeper and wild clematis—		
1 Douglas fir	35,953	
5 shrubs	11,250	
14 red cedar	1,000	
		48,203
Other shrubs and herbs and trees		5,967

APPENDIX H H H.

RECONNAISSANCES, EXPLORATIONS, AND WORK IN THE FIELD, IN MILITARY DIVISIONS AND DEPARTMENTS.

H H H 1.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE LAKES.

REPORT OF COL. OSWALD H. ERNST, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

HEADQUARTERS DEPARTMENT OF THE LAKES,
OFFICE OF THE ENGINEER OFFICER,
Chicago, Ill., July 3, 1903.

GENERAL: I have the honor to submit the following report as engineer officer of the department for the fiscal year ending June 30, 1903:

The following field work has been done during the year:

A survey was commenced on the 23d of May of the proposed addition to the reservation of Fort Sheridan, Ill. The work was completed and the necessary maps constructed.

On June 22 a survey of the reservation of Columbus Barracks, Ohio, was commenced. The field work was finished June 30, 1903, and the construction of the maps is now in progress.

The usual routine work has been performed in the office, maps have been furnished for the information of the officers at these headquarters and in the department, and drawing material and surveying instruments have been issued to the engineer officers at posts in the department upon requisition.

Very respectfully, your obedient servant,

O. H. ERNST,
Lieut. Col., Corps of Engineers, U. S. Army,
Engineer Officer, Dept. of the Lakes.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

H H H 2.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF CALIFORNIA.

ANNUAL REPORT OF COL. DAVID P. HEAP, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

HEADQUARTERS DEPARTMENT OF CALIFORNIA,
ENGINEER OFFICE,
San Francisco, Cal., July 7, 1903.

GENERAL: Since rendering my last report of operations for the fiscal year ending June 30, 1902, I have the honor to report that under paragragh 9, Special Orders, No. 261, Headquarters of the Army, Adju-

tant-General's Office, series of 1901, I have been on duty at these headquarters as engineer officer.

Civil-service clerk, Clement Winstanley, in the Adjutant-General's Department, detailed in this office, was continuously on duty until May 31, 1903, when he was transferred to the Engineer Department at Large as draftsman, still continuing his duties here.

A road from the town of Sausalito to Fort Baker, mentioned in my former report, has been completed by prison labor and has proved a great benefit to the post, which now possesses an 18-foot road, practically level, leading from the gate of the reservation to the top of the grade leading down to the post. This grade has also been greatly modified and improved.

The road at Alcatraz Island, also mentioned in my former report, has been commenced and partly finished by prison labor, this office having been called upon from time to time to establish grades and set stakes to which the road has been built.

Under paragraph 3, Special Orders, No. 125, Headquarters Department of California, series 1902, C. Winstanley (then civil-service clerk) was ordered to Monterey, Cal., to report upon the condition of the boundary fences on the military reservation in that city, receiving also instructions to run lines limiting the opening of a certain gravel quarry from which the city of Monterey had permission to take material for road building. A report and map showing the work accomplished was submitted to the adjutant-general of the department.

This office was called upon by the post quartermaster at the Presidio of San Francisco to run levels and lay off curves for a gutter to be built on that reservation.

A scheme for steel-safety shields for a 300-yard rifle range at the Presidio was evolved by the then department commander, Maj. Gen. R. P. Hughes; it was elaborated and surveys and drawings made in this office. The range is now completed and in use for small-arms practice.

Paragraph 6, Special Orders, No. 168, from these headquarters, July 31, 1902, ordered Capt. (now Maj.) E. H. Plummer, Tenth Infantry (now Third Infantry), constructing quartermaster for the proposed post at Monterey, Cal., Mr. C. Winstanley, civilian clerk, and Mr. W. H. Ball, superintendent of construction, to proceed to that city upon business pertaining to the building of a military post on the reservation there situated.

C. Winstanley, civilian clerk, was (by paragraph 4, Special Orders, No. 198, Headquarters Department of California, September 5, 1902) again ordered to Monterey with instructions to survey the boundaries of the military reservation and adjoining land. Owing to a lack of available information and data as to said boundaries (the only available being a small map issued by the surveyor-general for California in 1867), the initial point used by the city of Monterey in its official survey was adopted and the lines run in accordance therewith.

This office was also called upon to lay off the location of all the buildings of the post, run lines of sewers, and do all the surveying incidental to building the new post.

A survey of adjoining land, which the city of Monterey proposed to donate to the United States Government for military purposes was also made.

At the request of the commanding officer, Presidio of San Francisco, a survey of a proposed new road was made from the intersection of Broadway and the eastern boundary of the reservation to Central avenue

and the southern boundary of the same. Profiles and sections were made and submitted. I do not know officially whether this road has been built.

Under instructions contained in an indorsement on a communication from the commanding officer, Fort Baker, Cal., this office indicated on an existing map the line of a proposed and much needed road at that post, a report, illustrated by photographs, taken by me of the country traversed, together with map and estimate of cost, was submitted. The construction of this road is now under consideration.

Under paragraph 4, Special Orders, No. 50, current series from these headquarters, I proceeded to Monterey, Cal., on business connected with the resurvey of the boundaries of the military reservation and the survey of additional land adjoining said reservation. Under paragraph 5 of the above recited special order, the civilian clerk detailed for duty in this office was ordered to the same city to carry out the necessary surveying. Additional information in the meantime having been obtained as to boundaries, witness trees, etc., I discovered that the field notes from the surveyor-general's office and the boundaries on the ground could not be made to agree, a compromise was agreed upon which seemed to satisfy all parties concerned. Reports on this subject were submitted to the adjutant-general of the department

A piece of land, 104.17 acres in extent, immediately adjoining the existing reservation at Monterey, Cal., was surveyed and monumented with granite at the expense of the present owner. The city of Monterey proposes to donatè this land to the United States for a target range and for the cantonment of a squadron of cavalry.

Great strain has fallen on the resources of this office in order to supply the ever increasing demand for surveying instruments and appliances for the instruction of officers and others in regimental lyceums and schools. The entire supply on hand having been exhaused, requisition was made on the engineer depot for a further supply, which arrived at this office on the 1st instant.

I was also called upon to report upon the most feasible plan to stop the inflow of water into the basement of one of the lately completed barracks at Fort Baker. My recommendations were contained in an indorsement of February 20, 1903, returning the original communication to the adjutant-general of the department.

A communication from the post quartermaster, Fort Mason, dated March 30, 1903, relative to the building of a concrete retaining wall along the easterly boundary of that reservation, having been referred to me by indorsement on April 16, was returned by me to the adjutant-general of the department on 23d of that month, accompanied by a drawing, prepared by me, of the proposed wall, with an estimate of cost.

This office was called upon to locate and lay off a range for small-arms practice at Benicia, Cal., in the vicinity of the barracks and arsenal at that town. Two journeys were therefore made by Mr. C. Winstanley, draftsman in the Engineer Department at large, under provisions of paragraphs 2, Special Orders 132 and 138, from these headquarters dated, respectively, June 15 and 22, when the necessary work was accomplished.

Very respectfully,

D. P. HEAP,
Lieut. Col., Corps of Engineers,
Engineer Officer.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

H H H 3.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE EAST.

ANNUAL REPORT OF LIEUT. COL. WILLIAM R. LIVERMORE, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

DEPARTMENT OF THE EAST,
ENGINEER OFFICE,
ROOM G 5, ARMY BUILDING,
New York City, June 30, 1903.

GENERAL: I have the honor to submit the following report of operations as engineer officer, Department of the East, for the fiscal year ending June 30, 1903:

At the time the last annual report was rendered Capt. William V. Judson, Corps of Engineers, was the engineer officer of this department. Under General Orders, No. 1, headquarters Department of the East, dated January 12, 1903, and in compliance with paragraph 20, Special Orders, No. 286, Headquarters of the Army, Adjutant-General's Office, series 1902, I was announced as engineer officer of the department.

The principal work in this office has been in connection with the preparation of numerous maps, etc., for the use of the commanding general, Department of the East, and furnishing information pertaining to engineer matters to the officers in this department.

During the year certain surveys of Government lands were made in Porto Rico, and in compliance with instructions of the Chief of Engineers, dated January 22, 1903, payment for these surveys was made from this office.

The usual routine work has been performed in this office during the year.

Money statement.

June 30, 1903, amount withdrawn from United States Treasury during the fiscal year 1903, from allotments aggregating $4,800 made by the Chief of Engineers to the engineer officer, Department of the East	$3,900.00
June 30, 1903, amount expended during the fiscal year	3,890.26
June 30, 1903, unexpended balance	[a] 9.74

Very respectfully, your obedient servant,

W. R. LIVERMORE,
Lieut. Col., Corps of Engineers,
Engineer Officer, Department of the East.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

[a] Will be deposited to credit of the United States during July, 1903.

H H H 4.

OPERATIONS OF THE ENGINEER DIVISION OF THE PHILIPPINES.

REPORT OF LIEUT. COL. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

HEADQUARTERS, DIVISION OF THE PHILIPPINES,
OFFICE OF THE CHIEF ENGINEER OFFICER,
Manila, P. I., July 13, 1903.

GENERAL: I have the honor to herewith submit my annual report for the fiscal year ending June 30, 1903:

OFFICE WORK.

The office work during the year has been the routine work incident to the management of public works.

The following officers have been on duty in the office or under the immediate supervision of the chief engineer officer of the division:

Maj. Clinton B. Sears, from July 1, 1902, to May 7, 1903. Relieved per paragraph 1, Special Orders, 32, dated Manila, March 25, 1903.

Maj. Curtis McD. Townsend, from June 6, 1903, to date.

Capt. Henry Jervey, from July 1, 1902, to date. Assistant to chief engineer officer.

Lieut. Lytle Brown, from July 1, 1902, to September 17, 1902. Relieved per paragraph 8, Special Orders, 223, dated Manila, September 17, 1902. Assistant to the board of officers on the defenses of the Philippine Islands.

Lieut. Arthur Williams, from July 1, 1902, to September 22, 1902. Relieved per paragraph 3, Special Orders, 228, dated Manila, September 22, 1902. In charge of the drafting room.

In the map department one American and six native draftsmen have been employed. An engineer soldier has been detailed in charge of the printing room, with a native assistant.

The following new maps have been made during the year:

Philippine Archipelago (three new maps).
Mindanao Island (based on map loaned by Jesuits).
Map showing telegraph and cable lines operated by United States Signal Corps.
Malagi Island, by Lieut. Arthur Williams, Corps of Engineers.
Malagi Island, by Lieut. Warren T. Hannum, Corps of Engineers.
Cuyo Islands.
Jolo Island.
Department of Luzon.
Department of the Visayas.
Department of Mindanao and Paragua.
Northern approach to Cebu Harbor.
Southern approach to Cebu Harbor.
Iloilo Harbor.
Cagayan River, surveyed by Lieut. Lytle Brown, Corps of Engineers.
Province of Ambos Camarines.
Province of Bataan.
Rizal province.
Inch map of Luzon, sheets Nos. 5, 7, 46, 49, and 52.
Polyconic map, one-half inch scale, seven sheets compiled into four sections traced and issued.

Besides the new work, a great many of the old maps have been added to and corrected as more reliable information has been obtained.

The new maps of the Philippine Archipelago are as follows:

A general map, traced from map issued last year, showing no divisions or boundaries except province lines.

Division of the Philippines, showing stations occupied by troops from September, 1901, to December, 1901.

Division of the Philippines, showing stations occupied by troops July 31, 1902.

The new general map was made on account of a question of the accuracy of the boundaries in the southern seas.

The state of the map work in the islands is about as follows:

ISLAND OF LUZON.

The west coast down to the Gulf of Lingayen, the central portion extending eastward to the divide, and the provinces of Cavite, Laguna, and Batangas are mapped with considerable accuracy on a scale of 1 inch to a mile. The southern peninsula and the Cagayan Valley fairly mapped and the remainder of the island poorly mapped.

ISLAND OF MINDORO.

The northeast coast and Paluan Bay well mapped, also a survey of the southwestern part of the island from Mangarin on the southwest to Bulalacao on the south, an area of about 750 square miles, showing topography and contours, made by members of Second Battalion of Engineers.

ISLAND OF PANAY.

The entire island is accurately mapped on a scale of 1 inch to 1 mile, but no contours are used, the topography being shown by hachures.

ISLAND OF NEGROS.

Entire island poorly mapped.

ISLAND OF CEBU.

A map extending across the island and embracing about one-third of its territory has recently been made by Company F, Second Battalion of Engineers. The scale is 1:60,000, with contour interval of 200 feet, and the entire map is reported as very accurate. This is the first extensive piece of contouring done in the division. The remainder of the island is poorly mapped.

ISLAND OF SAMAR.

A new map has been started, based on D'Almonte and Coast and Geodetic Survey charts. Nothing has been put on this map but the information turned in from American sources, and is being added to from time to time as the information arrives.

ISLANDS OF BOHOL AND LEYTE.

All existing maps reported as wholly unreliable.

ISLAND OF MINDANAO.

The new map spoken of in last year's report (scale, 1:200,000) has been divided into five sections. It has been greatly added to from notes and sketches made by engineer officers and men of the Second Battalion of Engineers, Coast and Geodetic Survey charts, and such other information on file in this office deemed accurate.

During the year more than 4,000 blueprints have been issued, more than 1,000 of which were census maps prepared for General Sanger as chief of bureau.

The Coast and Geodetic Survey suboffice has supplied this department with charts and with the latitude and longitude of 13 points distributed throughout the islands.

In addition to the foregoing maps, the following surveys have been plotted or traced in this office:

Mariveles two-company post, by Lieut. Clarence O. Sherrill, Corps of Engineers.
Paniquian Valley four-company post, by Lieut. William A. Mitchell, Corps of Engineers.
Reservations, entrance to Manila Bay, this office.
Camp Stotsenberg, Pampanga Province, by Capt. George B. Pritchard, Fifth Cavalry.
Angeles preliminary survey, report of, by Lieut. Lewis H. Rand, Corps of Engineers.
Arayat preliminary survey, report of, by Lieut. Lewis H. Rand, Corps of Engineers.
Guadalupe, Rizal Province, post reservation, by Corporal McCracken, Company H, Second Battalion of Engineers.
Corregidor Island post, by Corporal Clairborne, Company E, Second Battalion of Engineers.
Three maps Calbayog, Samar, post, by Sergeant Lamke, Company E, Second Battalion of Engineers.
Laguan, Samar, by Lieut. James A. Woodruff, Company E, Battalion of Engineers.
Lucena Reservation, Tayabas Province, by Lieut. Oscar Foley, Sixth Cavalry.
Los Baños Reservation, by Lieut. George B. Pillsbury, Corp of Engineers.
Los Baños Reservation, by Lieut. William G. Caples, Corps of Engineers.
Tamauini Reservation, by Capt. George D. Guyer, Sixteenth Infantry.
Cauayan Infantry Barracks, by Lieut. Gustave R. Lukesh, Corps of Engineers.
Tamauini Infantry Barracks, by Lieut. Gustave R. Lukesh, Corps of Engineers.
Site for new post, Bayambang, by Lieut. Clarence O. Sherrill, Corps of Engineers.
Site for new post, Bayambang, by Lieut. Clarence O. Sherrill, Corps of Engineers.
Calumpan Point Reservation, by Lieut. George B. Pillsbury, Corps of Engineers.
Lasisi Point Reservation, by Lieut. George B. Pillsbury, Corps of Engineers.
Tacloban, Leyte, by Lieut. Charles S. Tarlton, First Infantry.
Jolo Reservation, by Col. William M. Wallace, Fifteenth Cavalry.
Jolo Reservation. No signature.
Camp Vicars, Mindanao, by Private A. Benedetto, Company G, Second Battalion of Engineers.
Luneta Barracks and Camp Wallace site, by Lieut. Gustave R. Lukesh, Corps of Engineers.
Pandacan powder house, by Corpl. F. W. Pitts, Company H, Second Battalion of Engineers.
Cuartel España, by Lieut. Gustave R. Lukesh, Corps of Engineers.
Malate Barracks, by Corpl. J. A. Jones, Company E, Second Battalion of Engineers.
Army and Navy Club, by Corpl. J. A. Jones, Company E, Second Battalion of Engineers.
Fort Santiago, by Lieut. Gustave R. Lukesh, Corps of Engineers.
First Reserve Hospital and Medical Supply, by Private L. H. Allen, Company H, Second Battalion of Engineers.
Fort San Antonio Abad, by Lieut. Gustave R. Lukesh, Corps of Engineers.
Ground for field games, Luneta, by Lieut. James A. Woodruff, Corps of Engineers.
Fort San Antonio Abad, by Lieut. Amos A. Fries, Corps of Engineers.
Intramuros along Pasig River, showing wall and moats, this office.
Mariveles, by Lieut. James A. Woodruff, Corps of Engineers.

Parang, Mindanao, by Capt. Thomas F. Maginnis, Twenty-seventh Infantry.
Bayambang Reservation, by members of Company H, Second Battalion of Engineers.
Bayambang Reservation, by Lieut. Clarence O. Sherrill, Corps of Engineers.
Fort William McKinley, in five sections, by Lieut. Edward M. Markham, Corps of Engineers.
Fort William McKinley, reduced, this office.
Fort William McKinley, water tower and plan of roads, by Capt. William W. Harts, Corps of Engineers.
Military residence for commanding general, plan of elevation, by Corpl. F. W. Pitts, Company H, Second Battalion of Engineers.
Military residence for commanding general, plan of ground floor, by Corpl. F. W. Pitts, Company H, Second Battalion of Engineers.
Military residence for commanding general, plan of second floor, by Corpl. F. W. Pitts, Company H, Second Battalion of Engineers.
Lucena Military Reservation, showing plan of roads, water system, and buildings.

In addition to the above, considerable work has been done in making drawings and blue-print copies thereof for the board of officers on the defenses of the Philippine Islands.

The following special reports and estimates have been made during the fiscal year:

On a general project for meeting the needs of the por of Iloilo, by Lieut. William Kelley, Corps of Engineers.

On a survey of the mouth of the Cagayan River, with certain recommendations concerning the improvement of the port at Aparri, by Lieut. Lytle Brown, Corps of Engineers.

On a survey of the Paniquian Valley, Mariveles Bay, to determine the availability of Maraveles as a post site, by Lieut. William A. Mitchell, Corps of Engineers.

On the coal deposits of Bataan Island, by Lieut. Edward M. Markham, Corps of Engineers.

On the exploration of the Mariveles Reservation, Bataan, P. I., with a view to the selection of a site for a hospital and recuperation post, by Lieut. James A. Woodruff, Corps of Engineers.

On the amount of land needed for purposes of fortification at the entrance to Manila Bay, by Lieut. George B. Pillsbury, Corps of Engineers.

On the work accomplished by the detachment of engineers in the exploration of a part of the island of Mindoro, by Corpl. Edward C. Koppen, Company E, Second Battalion of Engineers.

On survey of property in Manila and vicinity, formerly pertaining to the Crown of Spain and now in use by the military, by Lieut. John R. Slattery, Corps of Engineers.

On survey of sites proposed for fortifications at Cebu, by Lieut. Warren T. Hannum, Corps of Engineers.

Besides the distribution of maps, this office has issued to officers all over the Archipelago a large amount of field survey and sketching instruments, drawing materials, etc., for their use in reconnaissance work.

ENGINEER TROOPS.

The entire Second Battalion of Engineers was on duty in the division until June 6, 1903, when Companies G and H were relieved, per General Orders, No. 34, Headquarters Division of the Philippines, May 5, 1903, and left for San Francisco on the U. S. Army transport *Thomas*, under command of Capt. William W. Harts, Corps of Engineers.

Companies I and K, Third Battalion of Engineers, under command of Maj. Curtis McD. Townsend, Corps of Engineers, arrived at Manila

May 27, 1903, as per General Orders, No. 10, Headquarters of the Army, Adjutant-General's Office, January 29, 1903.

These troops have been stationed as follows:

Headquarters Second Battalion, Cuartel de Malate, Manila, P. I., July 1, 1902, to June 6, 1903.

Company E, Second Battalion, Cuartel de Malate, July 1, 1902, to May 7, 1903; Iligan, Mindanao, May 13 to June 30, 1903.

Company F, Second Battalion, Mataling Falls, Mindanao, July 1, 1902, to November 6; Iloilo, Panay, November 25, 1902, to January 13, 1903; Camp Jossman, Guimaras Island, June 13 to June 30.

Company G, Second Battalion, at Camp 10 and Mataling Falls, Mindanao, July 1, 1902, to October 7; Iligan, Mindanao, October 17 to May 15, 1903; Cuartel de Malate, Manila, P. I. May 18 to June 6.

Company H, Second Battalion, Cuartel de Malate, Manila, P. I., July 1, 1902, to June 6, 1903.

Companies I and K, Third Battalion, Cuartel de Malate, Manila, P. I., May 27, 1903, to June 30.

The duties of the troops have consisted in road and bridge building, exploration and location of trails, reconnaissance, road sketching, map making, hydrographic, topographic and land surveying, photography, wharf building, superintendence of building of posts, barracks, and quarters, and other minor engineering work. When not detached for the above purposes the troops were regularly given infantry and engineering drills. The noncommissioned officers and selected privates were instructed in the use of the engineer transit and "Y" level and in taking and plotting notes for land and topographical surveying. Each noncommissioned officer available was detailed on special duty for one month to learn the elements of photography. In addition thereto the regular garrison duties have been performed.

From Companies E and H, Second Battalion, detachments have been detailed as follows:

About 30 men under Lieut. George B. Pillsbury and Lieut. William G. Caples, Corps of Engineers, were engaged in Batangas and Laguna provinces in road and bridge work, reconnaissance, surveying proposed sites for military posts, and preparing plans, estimates, and laying out the posts.

Four men under Lieut. Gustave R. Lukesh, Corps of Engineers, were engaged in the Cagayan Valley in road and bridge work until December 17, 1902.

Eleven men under Lieut. Lytle Brown, Corps of Engineers, were engaged at Aparri in a topographic survey of the mouth of the Cagayan River and in preparing plans and estimates for the improvement of the harbor until October 14, 1902.

At Fort William McKinley 30 men have been employed upon the preliminary work for the construction of the post.

Macadamized roads have been built to the sites of the barracks, quarters, and stables. Buildings were laid out and the erection of eight barracks commenced. A large scale topopraphical map of the reservation was prepared and monuments erected, a wharf and storehouse built, and an artesian well sunk.

This work under the engineer officer, Department of Luzon, was supervised by Lieut. Edward M. Markham, Corps of Engineers, until April 11, 1903; by Lieut. Gustave R. Lukesh, Corps of Engineers, until June 1, when the detachment was relieved by 30 men from Company K, Third Battalion of Engineers, under Lieut. Lewis H. Rand, Corps of Engineers.

Lieut. Warren T. Hannum, Corps of Engineers, with 10 men, was at Cebu during February, March, and April, engaged in surveys for fortification purposes.

Lieut. George B. Pillsbury, Corps of Engineers, with 12 men, was employed in laying out reservations for fortifications and artillery posts at the entrance of Manila Bay during the months of February, March, and April.

Lieut. James A. Woodruff, Corps of Engineers, and 13 men made an exploration of the Mariveles Reservation in March, with a view to the selection of a suitable site for a hospital and recuperation post above the 2,500-foot level.

Four men have been on Malagi Island since December, 1902, as overseers at the military prison, and 4 men have been engaged on an exploration of the island of Mindoro since January.

At the following localities topographical surveys were made for military reservations by the officers and men of the two companies:

Near Los Baños, Santo Tomas, Calamba, Angeles, Arayat, the military lands in Manila, near Bayambang, on Malagi Island, near Calbayog, Samar, near Santa Cruz, on Corregidor Island, near Mariveles, near Iloilo, Panay, on Guimaras Island, and near Laguan, Samar.

The duties and detachments of Company F were as follows:

The company was in camp at Mataling Falls, Mindanao, on the Malabang-Lanao road, engaged in reconnaissance and road and bridge work under Lieut. Earl I. Brown, Corps of Engineers, until November 6, 1902; 25 men were at camp 10 engaged in reconnaissance and road work with Company G, under Capt. Jay J. Morrow and Lieut. Elliott J. Dent, Corps of Engineers, until August 1. A four-span crib bridge over the Mataling River was completed on September 20. On October 21 the road from Malabang to Camp Vicars was completed. During this time detachments were sent out on reconnaissance with the troops in the field, the road was accurately surveyed, and a 5,000-foot base line established for future use in the Lake Lanao region. The road was kept in repair, bridges built, and surveys made at Malabang. On July 10 one of the sentinels at camp 10 was wounded by Moros, and on July 24 the camp was fired on by Moros. On November 6 the company moved to camp 10, on the 13th to Malabang, and on the 23d embarked for Iloilo, arriving November 25. Four men were at Cebu, Cebu, in charge of the engineer office until November 27. In December, 10 men made a topographic survey for a military post at Dumaguete, Negros; 10 men did the same work at Ormoc, Leyte, in December and again in March and April; 15 men in January and February, 1903, made a hydrographic survey of Buena Vista Harbor, Guimaras; 16 men were engaged during January and February in building a bridge at Tigbauan, Panay. On January 13 the company moved from Iloilo to Camp Jossman, Guimaras. Work was then commenced on a road from Buena Vista to the camp; 7 men were employed as overseers under Lieut. George R. Spalding, Corps of Engineers, and 300 native laborers were put at work; 10 men were engaged during February and March in a triangulation of Guimaras Island; 3 men were engaged during March in a survey for a military reservation at Iloilo. Since March 17, 3 men have been engaged in supervising the construction of a wharf at Buena Vista; 7 men were detached for duty at Iloilo at the engineer office and depot since January. In April a new site was selected for Camp Jossman and 10 men were employed in surveying the site.

The detachments and duties of Company G were as follows: Fifteen men under Lieut. Ernest D. Peck, Corps of Engineers, were at Parang, Mindanao, until May 25, engaged in building a road from Parang to Cotabato, and since November in constructing a wharf at Parang; 3 men were at Davao until September 25, building barracks and making road sketches; 1 man was at Matti until September 25 for road work; 3 men were at Makar until September 25, at work on the telegraph line; 1 man was at Jolo until May 21, on road work; 2 men were at Iligan until July 7, surveying the post; 45 men under Lieutenant Fries were at Zamboanga until November, engaged in constructing a wharf. The company headquarters with 26 men under Captain Morrow was at camp 10 on the Malabang-Lanao road engaged in constructing the road with Company F. All the work was done by the troops, there being five to six companies of infantry at work. The engineers were engaged mainly in bridge building, reconnaissance work, blasting, and other work requiring special training. At the end of July the road was open to Mataling Falls. On August 16 the company moved to Mataling Falls and was engaged with Company F in constructing a 4-span crib bridge over the Mataling River. This was completed on September 20, and work was then commenced on the road from the Mataling River to Camp Vicars. On October 7, Captain Morrow with 35 men left camp and marched to Malabang where they embarked for Iligan on the 12th, arriving October 17. A stop was made at Zamboanga, where all but 16 of Lieut. Amos A. Fries's detachment were embarked. The company then commenced work on road from Iligan to Lake Lanao. The work consisted in reconnaissance, cutting timber for bridges, staking out the road, preliminary clearing, and bridge building. On November 25 the company moved to camp No. 1, 4 miles from Iligan, 5 men being left at Iligan for a survey for a post and 3 men as overseers in the construction of a wharf. During November Lieutenant Fries and 3 men were on duty in the engineer office at Zamboanga; on December 9 he left with 7 men for Jolo and commenced the construction of a wharf at that place. Lieut. Lewis H. Rand, Corps of Engineers, arrived and assumed command of Company G on December 8, and was attached as engineer officer with the construction work. The work was executed mainly by the labor of the troops of the Tenth and Twenty-eighth Infantry, a few Moros being employed. The engineers were mainly employed as overseers, in building bridges and in blasting operations. Lieuts. Clarence O. Sherrill and William A. Mitchell, Corps of Engineers, arrived during February; the former was in charge of wharf construction at Iligan, and the latter was assigned to duty on the road. On March 13 company headquarters and 16 men under Lieutenant Rand moved to camp No. 4 on the road; a bridge and blasting squad of 8 men was left at camp No. 2 and Lieutenant Mitchell and 13 men at camp No. 3. At the close of April the road was practically complete to Pantar. On May 15 the company headquarters and 51 men under Lieutenants Rand and Sherrill left Iligan arriving at Manila May 17, they disembarked and took station at Cuartel de Malate, awaiting transportation to the United States.

From Companies I and K, Third Battalion, a detachment of 30 men under Lieutenant Rand has been detailed at Fort William McKinley.

Lieut. Henry C. Jewett, Corps of Engineers, and 6 men at Baguio, Bonguet, have been employed in making a topographical survey of a proposed military reservation and in constructing barracks and quarters.

Lieut. William P. Stokey, Corps of Engineers, and 4 men made a survey of Pasay Barracks.

Five men were ordered to Malagi Island for duty in connection with the construction of roads at that post.

Six men under Lieut. Hubert L. Wigmore, Corps of Engineers, have been detached for the purpose of developing a coal vein on the island of Bataan.

In addition to performing the duties above described, officers of the battalion have been on detached service as follows:

Capt. Henry Jervey, Corps of Engineers, Company E, was detailed for duty as assistant to the chief engineer officer, Division of the Philippines, and superintendent of light-house construction under the civil government.

Capt. William W. Harts, Company H, in addition to his duties as company commander, has served as engineer officer of the Department of Luzon, member of a board of officers constituted for the construction of Fort William McKinley, and member of boards of officers for the construction of posts at Manila, Corregidor Island, and Malagi Island, until June, when he was relieved by Capt. Spencer Cosby, Company I.

Capt. Robert McGregor, Corps of Engineers, Company F, was detailed for duty under the civil government as sanitary engineer for the Archipelago and city engineer of Manila. Died at First Reserve Hospital, Manila, P. I., December 23, 1902.

Capt. Jay J. Morrow, Company G, was engineer officer, Seventh Separate Brigade, to October, 1902, then of the Department of Mindanao, and engineer officer of the Lake Lanao expedition, October and November, 1902. Under orders to be relieved before July 15 by Capt. Chas. Keller, Company K.

Lieut. Earl I. Brown, Company F, engineer officer, Department of the Visayas, since October 8, 1902.

Lieut. Curtis W. Otwell, Corps of Engineers, Company F, detailed for the construction of a wharf at Calbayog, Samar, under the civil government.

Lieut. H. L. Wigmore, Company C, aid to Major-General Davis, commanding general, Division of the Philippines, since August 5, 1902.

Lieut. John H. Poole, Corps of Engineers, Company I, special duty, office adjutant-general, Division of the Philippines, since May 27, 1903.

IMPROVEMENT OF THE PORT OF MANILA.

Previous to the American occupation the Spanish Government had inaugurated an improvement of the port of Manila, and prior to 1898 had begun the construction of a western breakwater extending from the mouth of the Pasig River, a distance of about 7,000 feet, of which about 2,210 feet had been completed. An eastern breakwater of a length of about 600 feet had also been built. The United States Government of the Philippines has undertaken to finish the construction of a deep-water harbor. The work proposed is as follows:

1. To complete the western breakwater and extend it to the 30-foot contour, a distance of about 750 feet, and to build a detached breakwater 3,000 feet long, extending in a southeasterly direction, from a point near the outer end of the west breakwater.

2. To build a water-tight bulkhead along the 12-foot contour, approximately parallel to the shore west of the Walled City, and to extend the east breakwater about 875 feet until it joins this bulkhead, thus

forming an area of about 148 acres, which is to be filled to a height of $7\frac{1}{2}$ feet above mean low water with material dredged from the harbor.

3. To dredge an 18-foot channel parallel to the west breakwater, and a small inner basin affording connection from deep water in the harbor through a canal to the Pasig River.

4. To dredge an area of about 350 acres between the breakwater and the bulkhead to a depth of 30 feet at mean low water, to afford an anchorage for deep-draft vessels.

This work is to be done under an act numbered 22 of the United States Philippine Commission, dated October 15, 1900, appropriating $1,000,000 in the money of the United States for improving this port of Manila. By an amendment to this act authority has been given to incur additional obligations not exceeding $2,000,000 to the extent necessary for the execution of the work proposed to be done under the contract, and by an additional amendment, dated January 3, 1903, authority has been given to incur an additional obligation not exceeding $1,029,000.

The contracts for the work have been awarded to the Atlantic, Gulf and Pacific Company, of New York and San Francisco, and at the close of the last fiscal year the contractors had constructed 1,093 linear feet of timber bulkhead and deposited 17,715 tons of rock as filling and riprap for the same. On the east breakwater 416 long tons of rock had been placed.

During the present fiscal year 3,096 feet of timber bulkhead have been constructed and protected by 85,239 tons (of 2,000 pounds) of rock; 81,105 long tons of rock have been placed on the west breakwater, and 12,311 tons of rock on the east breakwater.

A hydraulic dredge of a capacity of about 1,000 cubic yards per hour was completed and began work during the month of February, and since that time has dredged from the outer basin and deposited behind the bulkhead 1,550,233 cubic yards of material.

IMPROVEMENT OF THE PASIG RIVER.

The Bridge of Spain, situated about 6,000 feet above the mouth of the Pasig River, with its stone arches and clearance of but 16 feet at low water, forms a serious obstacle to navigation and limits the wharf front for seagoing vessels to the portion of the river below it. There is, however, a large commerce on the upper Pasig carried on in barges, cascos, and tugs, which have been constructed so as to pass under this bridge and three others which span the river above it.

During the Spanish occupation of Manila extensive improvements of the river were inaugurated. The river banks below the Bridge of Spain had been faced with substantial masonry walls founded about 12 feet below mean low water and capped by a granite coping extending about 7 feet above, and the channel of this portion of the river had been deepened to about 14 feet. On the upper Pasig numerous wharves had been constructed and the river straightened for a distance of 3,500 feet above the Mariquina River by what is known as Weylers cut.

The tributaries of the river during floods bring into it large amounts of sand and gravel, and storms in Manila Bay form a bar across its mouth.

The existing project proposes to maintain by dredging an 18-foot channel at mean low water across the bar and up to the Bridge of Spain, and a 6-foot channel through the upper river, the work to be done by Government plant and hired labor.

Two elevator dredges built for the Spanish Government have been repaired and are at work on the lower river.

At the close of the last fiscal year a channel through the bar 17 feet deep, 4,000 feet long, and 300 feet wide, with 325 feet width at the bend, had been completed and the channel of the Pasig River had been deepened to 18 feet over a width of 250 feet, through a linear distance of completed channel equivalent to 3,000 feet. The canal connecting the river and harbor basin had been dredged to a depth of 15 feet. The total amount dredged was 472,804 cubic yards.

During the present fiscal year the plant has been increased by three steel dump scows, built at the shops of the works of the port, and a small 30-foot launch constructed. The old wall at the entrance to the canal has been removed to a depth of 12 feet. The channel across the bar has been redredged to a depth of 20 feet below mean low water and width of 300 feet. In the river a channel between 400 and 500 feet wide to a depth of 19 feet at mean low water has been dredged to the Bridge of Spain; 696,264 cubic yards of dredged material were removed during the year.

For dredging the upper Pasig River a dipper dredge of 1¾ yards dipper capacity has been constructed, the hull having been built at the works of the port and the machinery purchased in the United States. Three wooden dump scows have also been built. Due to the difficulty of disposing of the dredged material, it was decided to place a centrifugal pump on one of the scows for the purpose of pumping the material on land. The pump has been ordered from the United States and is being set up. The dipper dredge is being tested, but is not yet in good working order.

The shops of the works of the port and the dry dock have been run to their full capacity during the year and have accomplished a large amount of work. Whenever the dry dock has not been needed for the vessels employed on the works, vessels belonging to the quartermaster's department, the coast-guard service, the customs service, and to the Marine-Hospital Service have been docked and charged the actual cost plus 10 per cent for wear, tear, and renewal. It has been used 128 days by these departments.

THE NEW DRAWBRIDGE OVER THE PASIG RIVER.

In connection with the improvements of the port which have been inaugurated, it is proposed to construct a drawbridge across the Pasig River near its mouth to afford communication from the new harbor front to the business portion of the city. Surveys and maps of the site have been made, the necessary borings to determine the nature of the underlying strata completed, and details and plans for the bridge prepared and filed.

ROADS AND BRIDGES.

Work on the construction and repair of roads and bridges has been carried on under an appropriation from insular funds, act No. 1, United States Philippine Commission, of $2,000,000, Mexican.

The islands have been divided up into districts, each under the charge of an officer of the Army, assisted by noncommissioned officers and privates of the engineer battalions, who have acted as inspectors, overseers, and foremen. Most of the expenditure under this act was made prior to June 30, 1902, and the operations of the present fiscal

year have in general consisted in closing out work previously begun. As fast as the work in each district has been completed or the allotted funds exhausted, the plant purchased from insular funds has been turned over to the provincial supervisors in accordance with the orders of the War Department and the maintenance of the roads and bridges left to civil authorities.

A financial statement is hereto appended.

FINANCIAL STATEMENT.

Funds allotted by the Chief of Engineers, U. S. Army.

[United States currency.]

Received:		
Civilian assistants to engineer officers, 1903	$1,0000.00	
Engineer equipment of troops, 1903	2,000.00	
Sites for fortifications and seacoast defenses	3,747.06	
		$15,747.06
Expended:		
Civilian assistants to engineer officers, 1903	5,871.19	
Engineer equipment of troops, 1903	344.83	
Sites for fortifications and seacoast defenses	977.72	
Deposited to credit of United States Treasury	5,783.98	
		12,977.72
Balance on hand (sites for fortifications, etc)		2,769.34

Insular funds.

[Mexican currency.]

Act 1, United States Philippine Commission: Repairs to roads and bridges, Philippine Islands:		
Balance on hand July 1, 1902		$80,801.02
Expended:		
Transferred to officers for construction	$38,963.04	
Expended for supplies	130.20	
Expended for salaries and wages	17,126.84	
Expended for services not personal	1,445.29	
Refunded to treasurer Philippine Archipelago	23,135.65	
		80,801.02
Act 311, United States Philippine Commission: Calamba-Batangas road:		
Balance on hand July 1, 1902		26,000.00
Transferred to officers for construction		26,000.00

Act 22, United States Philippine Commission: Improvement of the port of Manila:

[United States currency.]

Balance on hand July 1, 1902		65,537.82
Received during the year (accountable warrants)		830,636.67
Total funds received		896,174.49
Expended during fiscal year:		
Salaries and wages	$101,304.52	
Services not personal	4,802.51	
Supplies and material	89,716.49	
Atlantic, Gulf and Pacific Company (contract)	586,018.61	
Pun Lung (contract, scows)	20,400.00	
		802,242.13
Balance on hand		93,932.36

Act 333, United States Philippine Commission: Survey of Cagayan River:

Balance on hand July 1, 1902		$2,984.43
Expended for supplies	$239.98	
Expended for salaries and wages	210.69	
Expended for services not personal	60.80	
Refunded to treasurer Philippine Archipelago	2,472.96	
		2,984.43

Respectfully submitted.

CHAS. E. L. B. DAVIS,
Lieut. Col., Corps of Engineers, U. S. Army,
Chief Engineer Officer of the Division.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

H H H 5.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE MISSOURI.

ANNUAL REPORT OF MAJ. SMITH S. LEACH, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
ENGINEER OFFICE,
Fort Leavenworth, Kans., June 30, 1903.

SIR: I have the honor to submit the following report of work during the fiscal year ending this date.

Maps of posts and reservations called for in General Orders, No. 14, Department of the Missouri, 1902, have been received from Jefferson Barracks, Mo., and Fort Reno and Fort Sill, Okla.

The maps of the other posts are in preparation. At Leavenworth and Riley the magnitude of the work involved at Fort Robinson, the disappearance of the initial point of the old survey, and at several posts the frequent changes of engineer officers have operated to delay completion.

A topographical assistant will be sent to Fort Robinson about September 1, to attempt to recover the position of the old flagstaff, upon which the boundary of the reservation depends.

A map of the Fort Riley Reservation and surrounding country, and another on a larger scale of the reservation only, were prepared, and a large number of blueprints made for distribution to officers of the various oganizations, regular and militia, participating in the field maneuvers at Fort Riley.

Another tracing was made and an edition of 500 copies lithographed for binding with the report of the chief umpire, this last under an especial allotment of funds from the Chief of Engineers.

The compilation of a map of the department has been in progress since January, 1903. The map will be 4½ feet by 6 feet, in four sheets. The projection is completed, the principal cities and towns platted from geographical coordinates, and the transfer sheets for about one-half the entire area are drawn. There is no map of the department with its present limits, and the latest of any considerable part of it is a map of the old Department of the Platte of 1889.

Routine work has been kept up, consisting of making tracings and blueprints for various posts, issue and receipt of engineer property, and correspondence. Until December, 1902, the office force consisted of a draftsman who gave part of his time to the ordnance and signal offices, and the rest to the engineer office. Since December, 1902, a topographical assistant has given his entire time to the engineer work.

Very respectfully,

SMITH S. LEACH,
Major of Engineers, Engineer Officer,
Department of the Missouri.

The ADJUTANT-GENERAL,
Department of the Missouri, Omaha, Nebr.

H H H 6.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE COLUMBIA.

ANNUAL REPORT OF MAJ. WILLIAM C. LANGFITT, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 15, 1903.

GENERAL: I have the honor to submit the following report of operations pertaining to my duties as engineer officer, Department of the Columbia, for the fiscal year ending June 30, 1903:

In compliance with Special Orders, No. 219, Adjutant-General's Office, 1902, and General Orders, No. 25, Headquarters Department of the Columbia, 1902, which provided for the transfer of the above-mentioned duties to me, all public property and records pertaining to the engineer office were transferred by Maj. William R. Abercrombie, Thirtieth Infantry, U. S. Army, under date of September 30, 1902.

The only funds disbursed by me during the year were for payment for services of civilian assistants. The records were gone over, useless material eliminated, and a complete new index made, all of which work was badly needed and required considerable time. One clerk and draftsman was continuously employed.

The assistant was employed in making maps of route marches, of the barracks, and in miscellaneous field work in connection with target range, roads, and gravel pit. A map of wharf was made for use in making repairs. Measurements of old and new buildings in relation to change of water and sewer pipes were taken and necessary drawings showing these changes were completed.

A survey was made of a part of the reservation to be cleared of underbrush, and maps of this survey and also plan and profile map of a survey showing proposed gymnasium sewerage and location of new gymnasium were furnished the quartermaster.

A survey for change in location of officers' quarters was also made for the adjutant-general.

The lines of sewer diversions from the post hospital and company quarters were laid out.

Surveys were made of the site and location established for new double battery quarters and bachelor officer quarters.

Sites for other buildings were also staked out and elevations established. A draft was also made in connection with a temporary guardhouse at the barracks.

Maps of the above surveys were furnished and miscellaneous blueprints and other details of work of minor importance were also furnished when required.

At the close of the year the field work and preparation of map for use of troops in the departmental maneuvers is in progress, and two additional men were engaged for the work.

A large number of original maps, tracings, blueprints, photographs, etc., have been made in the office, but numbers can not be given, as the records are incomplete for earlier months.

Statement of condition of allotments from appropriation for civilian assistants to engineer officers, 1903.

Allotted July 9, 1902		$1,500.00
Allotted October 21, 1902		500.00
		2,000.00
Amount expended during fiscal year	$1,468.33	
Balance unexpended and deposited to the credit of the Treasurer United States	531.67	
		2,000.00

Very respectfully, your obedient servant,

W. C. Langfitt,
Major, Corps of Engineers, U. S. A.,
Engineer Officer, Department of the Columbia.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

HHH 7.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE COLORADO.

REPORT OF FIRST LIEUT. HUGH A. DRUM, TWENTY-SEVENTH INFANTRY, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

Headquarters Department of the Colorado,
Engineer Office,
Denver, Colo., July 20, 1903.

Sir: I have the honor to submit the following report of this office for the fiscal year ending June 30, 1903.

PERSONNEL.

The following officers were in charge of this office during the year:

First Lieut. Burton J. Mitchell, Twelfth Infantry, aid-de-camp, from July 1, 1902, to March 1, 1903.

Maj. Charles A. Varnum, Seventh Cavalry, from March 2 to May 18, 1903.

First Lieut. H. B. Farrar, Artillery Corps, from May 19 to June 19, 1903.

First Lieut. Hugh A. Drum, Twenty-seventh Infantry, aid-de-camp, from June 20 to 30, 1903.

Under authority contained in letter from the Chief of Engineers, U. S. Army, the following were employed in this office during the year:

Mr. George D. James, draftsman, at $150 per month, from November 13, 1902, to January 16, 1903.

Mr. William C. F. Nespital, draftsman, at $125 per month, from January 17 to June 30, 1903.

Mr. Erwin Lewis, clerk, at $60 per month, from November 3, 1902, to May 31, 1903.

Mr. William R. Baker, clerk, at $60 per month, from June 8 to 30, 1903.

Mr. Nespital and Mr. Baker are appointees under the civil service, and are still employed in this office.

OFFICE WORK.

A new map of the Department of the Colorado has been compiled and completed during the year. It will be forwarded in a few days to the Chief of Engineers for examination and lithographing. Numerous tracings and blueprints of official maps have been made; instruments issued to engineer officers of posts; engineer property cared for, and the necessary clerical work has been performed during the year. The large number of maps in office have been classified and an index thereto is in course of preparation.

The offices assigned to the acting engineer officer of the department are not suitable for map making and solar printing and an additional room is needed, so that maps, instruments, etc., can be properly cared for.

Very respectfully,

H. A. Drum,
First Lieutenant, Twenty-seventh Infantry,
Aid-de-Camp, Acting Engineer Officer.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

APPENDIX I I I.

ERECTION OF NEW BUILDING FOR GOVERNMENT PRINTING OFFICE.

REPORT OF CAPT. JOHN S. SEWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

U. S. ENGINEER OFFICE FOR ERECTION OF
NEW BUILDING FOR GOVERNMENT PRINTING OFFICE,
Washington, D. C., July 17, 1903.

GENERAL: I have the honor to submit the following report of operations on the new building for the Government Printing Office, for the fiscal year ending June 30, 1903:

This building was authorized by the sundry civil act approved March 3, 1899, and its limit of cost was increased from $2,000,000 to $2,429,000 by a joint resolution approved February 17, 1900. For the wording of these acts reference is made to Appendix H H H, Annual Report of the Chief of Engineers for 1901.

Since the date of the last report the building has been practically completed, although considerable quantities of work remain to be done on the following items: Marble work in the main entrance; mosaic floors in the main entrance; decoration in the main entrance; vault doors; elevator inclosures and cars; electric wiring; pneumatic tubes; bronze doors, and lamp standards. In addition to this work there are some fireproof partitions wanted by the Public Printer, and the contractor for the wood-block floors is under the necessity of executing considerable repairs, due to the fact that he put some of the floors down too dry, and they subsequently swelled and came up in spots.

It is expected that the building will be completed in all its details by September 1, 1903, except for the pneumatic tubes, and such extra work as the Public Printer may want done, including the extra partitions already referred to.

The building has not been completed as promptly as was hoped for, largely owing to the great activity in all lines of the building trade, and to strikes and other causes not foreseen when the first estimate of time required was made, but it will be entirely finished within the authorized limit of cost, and possibly there will be a small balance to turn back into the Treasury.

Contracts have been let for everything required for completing the building in all its details, except for the extra partitions and such other extra work properly chargeable to the construction of the building as the Public Printer may desire to have put in.

The tabular statements following show the condition of the appropriation, contracts let (both completed and in force), and the amount of work accomplished better than an extended description.

The present condition of the appropriation is as follows:

Amount appropriated by act of March 3, 1899		$350,000.00
Amount appropriated by act of June 6, 1900		775,000.00
Amount appropriated by act of March 3, 1901		1,304,000.00
		2,429,000.00
June 30, 1903, amount expended to date		2,225,644.82
July 1, 1903, balance unexpended		203,355.18
July 1, 1903, outstanding liabilities	$41,625.04	
July 1, 1903, covered by existing contracts	117,330.60	
		158,955.64
July 1, 1903, balance available		44,399.54

A schedule of expenditures to date, under various heads, is as follows:

Excavation and earth filling	$38,846.06
Shoring, underpinning, etc	8,384.65
Concrete	68,789.67
Structural steel	473,534.85
Cast-iron bases	6,340.72
Cast-iron baseboard, etc	19,282.46
Miscellaneous steel work	6,956.96
Miscellaneous castings	2,491.84
Fireproofing	177,831.35
Brickwork	335,117.44
Cut stone and ornamental terra cotta	109,890.97
Door and window frames	95,841.18
Doors and windows	46,203.44
Stairways	22,215.70
Elevators	78,334.30
Plumbing and drainage	91,122.56
Heating and ventilation	69,614.83
Electric wiring	114,660.41
Filtered water system	9,300.00
Tanks	4,430.00
Painting	10,214.78
Timber floors	75,178.86
Tile flooring	11,697.91
Waterproofing	29,094.28
Granolithic and asphalt pavements	27,242.90
Traveling crane, scales, etc	5,116.50
Roofs	30,978.28
Steel and cast-iron floor finish	5,533.45
Concrete backing, brickwork in loft walls	5,588.90
Plastering	52,106.97
Coal to heat building during winter 1902–3	4,752.88
Subway under Jackson alley	1,203.18
Marble work	40,292.25
Decoration	9,865.45
Contingencies (architect's fees, preparation of plans, office expenses, supervision in field, etc.)	140,535.55
Tools, working plant, temporary buildings, etc	27,131.54
Miscellaneous labor and materials, holiday pay, etc	19,039.87
Total cost of work in place	2,274,762.94
Materials on hand	7,103.59
	2,281,866.53
Cash expenditures	2,225,644.82
Outstanding liabilities	41,625.04
Amount in abeyance pending litigation with Phoenix Iron Company on account of structural steel	14,596.67
	2,281,866.53

The total quantities of work done and materials in place in the permanent work are as follows:

Excavation	cubic yards	42,010
20-inch sewer in G street	linear feet	480
Terra-cotta drains:		
12-inch	do	690
8-inch	do	570
Fittings, all sizes	number	36
Concrete, all kinds	cubic yards	9,169
Bricks:		
Common	number	5,217,753
Face	do	2,689,463
Cement (for laying brick)	barrels	14,068
Sand (for laying brick)	cubic yards	5,675
Steel, erected in place	pounds	12,612,691
Cast-iron bases, erected	do	327,000
Fireproofing:		
Column covering	linear feet	3,430
Girder covering	do	33,259
Floor arches (terra-cotta)	square feet	282,769
Concrete floor construction	do	100,299
Concrete ceiling construction	do	204,800
Waterproofing:		
Asphalt surfacing	do	53,047
Flashing	linear feet	459
Wheel guards, angle guards, etc	number	100
Vitrified-brick paving	square feet	15,000
Asphalt paving in basement	do	46,556
Skylights on boiler house and engine room	number	2
Tile roofing on power house	square feet	6,440
Corrugated roofing on power house	do	6,440
Electrical installation:		
Terra-cotta conduit	linear feet	13,094
Flexible conduit	do	54,768
Lead bushings	pieces	14,000
Iron boxes	do	1,806
Enameled pipe	do	8,240
Fittings, all kinds	number	129,828
Wire, all classes	linear feet	349,672
C. S. switches	number	1,605
Distributing centers	do	90
Lead tubing	linear feet	1,082
Cut-outs	number	1,409
30-gallon galvanized boilers	do	7
Automatic switches	do	2
Castings, all kinds	do	1,310
$\frac{3}{4}$-inch black pipe	linear feet	807
Heating and ventilating:		
Black pipe—		
10-inch	do	527
8-inch	do	881
6-inch	do	282
5-inch	do	1,385
4-inch	do	400
3-inch	do	8,752
2-inch	do	527
$2\frac{1}{2}$-inch	do	6,329
$1\frac{1}{2}$-inch	do	910
$1\frac{1}{4}$-inch	do	1,042
1-inch	do	3,095
$\frac{1}{2}$-inch	do	3,795
Galvanized pipe—		
7-inch	do	74
6-inch	do	9
5-inch	do	2,215
4-inch	do	499

Heating and ventilating—Continued.		
Galvanized pipe—Continued.		
3-inch	linear feet	5
2-inch	do	52
1½-inch	do	100
1-inch	do	107
¾-inch	do	69
Cast-iron pipe, 8-inch	do	10
Fittings, all kinds	do	4,100
Ventilator frames and registers		911
Union valves		408
Radiators		484
Steam traps		1
Steam gauges		3
Plumbing:		
Oxidized pipe, 1½-inch	linear feet	100
Cast-iron pipe—		
8-inch	do	730
6-inch	do	468
5-inch	do	119
4-inch	do	684
3-inch	do	6
2-inch	do	65
Cast-iron fittings of all kinds	number	243
Black pipe—		
12-inch	linear feet	20
10-inch	do	50
8-inch	do	23
6-inch	do	21
3-inch	do	22
2-inch	do	731
1¼-inch	do	8
1-inch	do	58
1½-inch	do	100
½-inch	do	337
Galvanized pipe—		
7-inch	do	133
6-inch	do	1,713
5-inch	do	2,833
4-inch	do	5,165
3-inch	do	4,400
2-inch	do	9,539
1½-inch	do	4,416
1¼-inch	do	1,575
1-inch	do	7,045
¾-inch	do	947
½-inch	do	2,414
Fittings of all kinds		7,227
Clamps and pipe hangers		1,126
Drinking-fountain frames		64
Drinking fountains		64
Drinking-fountain traps		64
Slate urinals		14
Lavatories, complete		234
Closet frames		117
Glass for closet frames		234
Slop sinks, complete		19
Basins		494
Water-closets		187
Bath tub		1
Water regulators		10
Toilet-paper holders		125
Double special urinal		1
Soap dishes		269
Towel racks and screens		32
Marble lavatories		5
General closet partitions		93

Plumbing—Continued.		
2-inch oxidized brass traps		25
Office lavatories, complete		11
General lavatories, complete		3
Partition fittings		11
Towel racks		16
Partition frames with marble, complete		2
Special toilet-room fixtures	set	1
Cut stone work:		
Coursed ashlar, set in place	linear feet	7,528
Sills and lintels, set in place	pieces	1,986
Columns, bases, caps, and keystones, set in place	do	177
Terra-cotta trimmings:		
Bases		36
Caps		46
Arches		42
Terra cotta in separate courses	linear feet	15,900
Cast-iron door and window frames, set in place		1,042
Cast-iron column guards, set in place		1,360
Cast-iron stairways (main and side)		4
Cast-iron stairways (miscellaneous)		5
Cast-iron baseboard, set in place	linear feet	19,808
Cast-iron floor, set in place	square feet	4,711
Steel ladders, set in place	linear feet	1,740
Traveling crane in engine room		1
Platform scale in coal room		1
Tanks		10
Tile roofing on main building, etc	square feet	50,013
Tile floor storage-battery room	do	1,331
Copper flashing on roof	linear feet	2,854
Copper guttering for cornice	do	1,570
Mosaic and tile floors	square feet	25,336
Cement floors	do	304,700
Wood-block floor	do	250,554
Asphalt-block pavement	do	8,432
Safety stair treads	do	2,302
Cement sidewalks	square yards	1,868
Ventilators for fan openings		12
Limoid for plastering	tons	298
Plaster for plastering	barrels	1,125
Lime for plastering	do	500
Hair for plastering	bushels	450
Sand for plastering	cubic yards	1,220
Steel floor in foundry and wash room	square feet	4,690
Windows cleaned		1,250
Wrought-iron gate		1
Alignum fireproof doors	openings	123
Marble-work, practically completed.		
Elevators:		
Electric elevators	number	13
Electric form lift	do	1
Elevator inclosures	openings	35
Freight elevator door frames	number	7
Sliding shutters	do	2
Vault doors	sets	4
Decoration of executive offices and main-stairway halls about 85 per cent completed.		
Steel doors for vent shaft	number	21
Ventilating fans and motors	do	12
Paper chute	do	1
Press pits	do	5
Waterproofing exterior walls entirely completed.		

List of all contracts which have been let from the beginning of the work to the present time.

Date.	Name of contractor.	Subject of contract.	Price.	Actual or estimated total.	Present condition.
1899.					
July 15	S. Carmody & Son	Excavating and boring:			
		Trench excavation	75 cents per cubic yard		
		General excavation	44 cents per cubic yard	$19,120.57	Completed.
		Borings	$2 per linear foot		
Aug. 19	Thos. R. Riley	Lumber:			
		3 by 8 Virginia pine	$13.45 per thousand		
		6 by 6 Virginia pine	do		
		4 by 6 Georgia pine	$24.75 per thousand	1,823.65	Do.
		12 by 12 Georgia pine	$28.75 per thousand		
		8 by 8 Georgia pine	do		
Sept. 28	Columbia National Sand Dredging Co	Sand	95 cents per cubic yard	1,684.35	Do.
Sept. 28	The Cranford Paving Co	Broken stone:			
		1-inch stone	$2.24 per cubic yard	13,176.89	Do.
		2-inch stone	$1.90 per cubic yard		
Sept. 30	Jas. H. McGill	Portland cement	$2.43 per barrel	18,954.00	Do.
Oct. 4	Thos. Somerville & Sons	Pipe and fittings		1,815.29	Do.
Dec. 13	Standard Brick Co	Common red brick	$9.23 per thousand	4,328.25	Do.
1900.					
Mar. 14	The Cranford Paving Co	Waterproofing	Foundations, 25 cents square foot; vertical walls, 27 cents square foot; flashing horizontal courses against walls, 30 cents linear foot.	13,986.85	Do.
Mar. 26	The Phœnix Iron Co	Structural steel	Average price per pound, 3.67 cents	466,082.82	Do.
Apr. 23	Petersburg Iron Works	Cast-iron bases	1.89 cents per pound	6,323.93	Do.
May 15	Andrew Ramsay	Enameled bricks		59,736.30	Do.
July 23	N. J. Foundry and Machine Co	Electric hoists		6,430.00	Do.
Aug. 2	The Fawcett Ventilated Fireproof Building Co.	Terra-cotta fireproofing		114,436.42	Do.
Aug. 3	Bing Foundry and Machine Co	Cast-iron wheel guards		830.00	Do.
Aug. 4	The Brennan Construction Co	Concrete fireproofing		34,624.60	Do.
Aug. 6	Edwd. R. Diggs & Co	Light-face bricks		31,122.59	Do.
Aug. 6	Wm. D. Gill & Son	Lumber:			
		1 by 12 by 16 Virginia pine	$14.75 per thousand feet		
		1 by 6 by 16 Virginia pine	$12.75 per thousand feet		
		4 by 6 by 12 Virginia pine	18¼ cents per piece	7,766.55	Do.
		3 by 12 inches, Virginia pine	$14.25 per thousand feet		
		2 by 12 inches, Georgia pine	$20 per thousand feet		
Aug. 6	John B. Lord	Concrete sand	90 cents per cubic yard	14,753.95	Do.
		Building sand	do		
Aug. 10	Grove Lime and Coal Co	Lime	46½ cents per barrel	260.88	Do.
Aug. 10	James H. McCuen	1 and 2 inch broken stone	$1.74 per cubic yard	1,520.23	Do.

Aug. 11	The Cranford Paving Co	2-inch broken bricks 1-inch broken bricks	$1.89 per cubic yard $2.05 per cubic yard	7,948.28	Do.
1900.					
Aug. 16	Excelsior Terra Cotta Co	Ornamental terra cotta		28,616.31	Do.
Aug. 17	The Frederick Brick Works of Frederick County.	Brick		49,908.52	Do.
Aug. 21	Potomac Terra Cotta Co	Terra-cotta conduit		1,358.75	Do.
Aug. 21	The Burnet Co	Electrical supplies		5,048.15	Do.
Aug. 22	Cutter Electrical and Manufacturing Co	Switches and switch boxes		4,413.42	Do.
Aug. 23	Jas. H. McGill	Nonstaining Portland cement	$3.09 per barrel	2,465.82	Do.
Sept. 1	Addison H. Clarke	American Portland cement	$1.64 per barrel, net	32,119.34	Do.
Sept. 13	J. P. Falt	Cut stone		62,573.55	Do.
Sept. 17	Brown-Ketcham Iron Works	Cast-iron frames		102,478.67	Do.
Oct. 23	do	(Supplemental and modifying contract of Sept. 17, 1900.)			
Sept. 17	Chas. E. Ellicott	Cast-iron column guards		6,016.91	Do.
Sept. 18	Cribben & Sexton Co	Enameled pipe: 1¼-inch, 13 inches long 3-inch, 13 inches long 2-inch, 7 feet 3 inches long	 50 cents per piece 88 cents per piece $3.65 per piece	4,884.36	Do.
Sept. 18	Geo. W. Knox Express Co	Transporting white sand	$2.25 per ton of 2,000 pounds	1,905.41	Do.
Sept. 24	Crystal Sand Co	White sand	70 cents per ton of 2,000 pounds	592.70	Do.
Oct. 31	Seneca Stone Co	Cut stone		1,593.69	Do.
Nov. 5	Cuyler & Mohler	Pipe, fittings, etc		15,514.32	Do.
Nov. 20	Brennan Construction Co	Tile roofing	$2,100	2,100.00	Do.
Nov. 13	J. C. McFarland & Co	Corrugated roofing	$1,089	1,089.00	Do.
Nov. 12	Arthur E. Rendle	Skylights	$1,579.20	1,579.20	Do.
Dec. 18	H. S. Pilkington & Co	Mortar color	1⅛ cents per pound	853.19	Do.
1901.					
Jan. 21	Cuyler & Mohler	Pipe and valves		8,784.62	Do.
Feb. 1	The C. J. McCubbin Co	Fittings, pipe hangers, and clamps		1,363.45	Do.
Mar. 28	C. A. Schneider's Sons	Steel water tanks	$418 each	2,508.00	Do.
Apr. 25	Pawling & Harnischfeger	Electric traveling crane	$4,900	4,900.00	Do.
June 6	Charles E. Ellicott	Insulator clamps		3,048.35	Do.
June 7	The Burnet Co	Porcelain insulators		4,222.67	Do.
June 7	New Jersey Foundry and Machine Co	Cable supports		4,320.00	Do.
June 10	Cuyler & Mohler	Pipe and fittings		336.56	Do.
June 13	H. C. Roberts	Bolts and washers		162.41	Do.
June 26	American Mason Safety Tread Co	Safety treads		3,683.20	Do.
June 27	New Jersey Foundry and Machine Co	Ventilating registers and 2 steel tanks		2,511.24	Do.
July 3	Mason Regulator Co	2 steam-reducing valves	$200 each	400.00	Do.
July 17	Charles E. Ellicott	Steam-heating coils		17,946.89	Do.
July 2	Brown-Ketcham Iron Works	Steel ladders		929.25	Do.
July 15	The Champion Iron Co	Stair work Manhole covers, etc Cast-iron drinking-fountain frames, etc		16,310.00 1,393.06 159.00	Do.
July 23	Speakman Supply and Pipe Co	Urinals		2,500.50	Do.
July 26	J. L. Mott Iron Works	Plumbing fixtures, etc		24,731.67	Do.
July 30	Zellers & Co	Cast-iron radiators		1,138.55	Do.
July 30	Charles E. Ellicott	Partition frames		2,051.94	Do.

List of all contracts which have been let from the beginning of the work to the present time—Continued.

Date.	Name of contractor.	Subject of contract.	Price.	Actual or estimated total.	Present condition.
1901.					
Aug. 22	Brown-Ketcham Iron Works	Cast-iron floor plates	55 cents per square foot	$2,591.05	Completed.
Aug. 26	Excelsior Terra Cotta Co	Terra-cotta imposts	45½ cents per linear foot	542.21	Do.
Sept. 4	Thos. Somerville & Sons	1-inch galvanized pipe	9.1 cents per linear foot	227.89	Do.
Sept. 12	do	2-inch galvanized pipe	19½ cents per linear foot	643.53	Do.
Sept. 18	James B. Lambie	Steel cable sash chain Fasteners	6.9 cents per linear foot 11 cents per set of 4	1,593.23	Do.
Oct. 5	Brennan Construction Co	Asphalt floor in basement	30 cents per square foot	792.90	Do.
Oct. 9	Thos. W. Smith	Plate racks	$299	299.00	Do.
Oct. 19	Church & Stephenson	Virginia pine: 1 by 12 inches by 16 feet 1 by 6 inches by 16 feet	$15.50 per 1,000 feet B. M	465.00	Do.
Oct. 21	Barber & Ross	Sash weights	Compressed lead, 5.69 cents per pound; cast iron, 1.03 cents per pound.	1,505.10	Do.
Oct. 23	Thos. W. Smith	Window sash		2,857.99	Do.
Oct. 23	H. J. M. Howard	Fire hose, etc		1,880.00	Do.
Oct. 25	O. A. Danzenbaker	Pipe covering		7,019.00	Do.
Oct. 25	Cutter Electrical and Manufacturing Co.	Distributing centers	Lighting, $172.50 each; power, $205 each	18,575.00	Do.
Oct. 25	Nathan Hutkoff	Glass		11,564.94	Do.
Nov. 7	Speakman Supply and Pipe Co	Brass sleeves	$14.343 each	545.03	Do.
Nov. 11	Church & Stephenson	Virginia pine, 1 inch by 6 inches by 16 feet.	$16 per 1,000 feet B. M	240.00	Do.
Nov. 20	Steele & Condict	Cold drinking-water system	$9,300	9,300.00	Do.
Nov. 27	Geo. F. Blake Manufacturing Co	Electrically driven pumps		10,074.00	Do.
Nov. 22	Albert & J. M. Anderson Manufacturing Co.	Distributing centers	$624.50 each	1,249.00	Do.
Nov. 29	Otis Elevator Co	Electric elevators		85,375.00	In force.
Dec. 5	Wm. H. Dyer	Sliding doors		536.00	Completed.
Dec. 11	Cutter Electrical and Manufacturing Co.	Finishing ventilating registers		400.00	Do.
Dec. 20	Baltimore Iron Works	Metal ties for cornice		854.46	Do.
Dec. 27	Mack Manufacturing Co	Vitrified paving blocks	$21.10 per thousand	945.53	Do.
Dec. 27	Brown-Ketcham Iron Works	Cast-iron door frames		826.00	Do.
1902.					
Feb. 3	Nathan Hutkoff	Glazing sash		800.00	Do.
Feb. 18	National Mosaic Co	Mosaic floors, etc	White vitrified tile, 38 cents per square foot; plain white mosaic, 41 cents per square foot; mosaic floors, 79 cents per square foot.	15,132.70	In force.
Feb. 21	Safety Insulated Wire and Cable Co	Wire and cables		21,979.53	Completed.
Feb. 24	James G. Wilson	Wood-block floors	Hard maple, 27 cents per square foot; quartered oak and mahogany, 90 cents per square foot.	72,585.00	In force.
Feb. 24	Burdett-Rowntree Manufacturing Co	Automatic door openers		5,200.00	Do.

Mar. 6	Brennan Construction Co	Ventilators		942.00	Completed.
Mar. 6	Cranford Paving Co	Asphalt floors, etc	Asphalt pavement, 21¼ cents per square foot; copper guttering and flashing for main cornice, exterior fronts, $2.20 per linear foot; copper flashing for main cornice in interior court, 95 cents per linear foot.	13,032.44	Do.
Mar. 14	Brennan Construction Co	Mortar course on roof		440.00	Do.
Mar. 17	Ambrose B. Stannard	Mahogany doors		987.75	In force.
Mar. 19	New Jersey Foundry and Machine Co	Alignum fireproof doors		3,600.00	Do.
Mar. 17	Kinnear Manufacturing Co	Rolling steel shutters for elevators		6,808.00	Do.
Mar. 19	De Kosenko Manufacturing Co	Elevator inclosures		32,176.00	Do.
Mar. 20	Rudolph, West & Co	Hardware		3,422.23	Do.
Mar. 25	do	Floor hinges		508.16	Do.
Apr. 10	Neuchatel Asphalte Co., Limited	Tile and asphalt roof work; copper flashing for roof; tile and asphalt floor in storage-battery room.	32¼ cents per square foot; 93 cents per linear foot; 38 cents per square foot.	19,413.86	Do.
Apr. 8	Otis Elevator Co	Supplemental to contract of Nov. 29, 1901, for elevators.		3,680.00	Do.
May 13	S. Dana Lincoln	Portland cement	$1.28 per barrel	19,212.48	Completed.
May 21	J. L. Mott Iron Works	Steel and bronze door saddles and towel racks and screens.		5,107.73	Do.
June 27	Sprague Electric Co	Ventilating fans		13,278.00	Do.
June 27	American Safe and Lock Co	Vault doors	$202.18 per set	1,819.62	In force.
June 26	Brown-Ketcham Iron Works	Extra cast-iron frames		608.00	Completed.
June 24	Baltimore Iron Works	Steel work for operating slots for elevators.		843.50	Do.
July 1	S. Dana Lincoln	Plaster of Paris	$1.79 per barrel of 300 pounds	537.00	Do.
July 9	Brennan Construction Co	Ventilators		650.00	Do.
July 19	S. Dana Lincoln	Limoid	$7.50 per ton	1,700.00	Do.
Aug. 8	Caffall Brothers	Waterproofing exterior walls		11,086.00	Do.
Aug. 9	Neuchatel Asphalte Co., Limited	Copper coping		1,195.00	Do.
Sept. 25	Otis Elevator Co	Additional platform for elevator No. 12		340.00	Do.
Sept. 26	Brown-Ketcham Iron Works	Extra labor on cast-iron baseboard	65 cents per hour per man		In force.
Sept. 27	Southern Expanded Metal Co	Metal lathing and furring		3,947.20	Completed.
Oct. 10	F. S. Gichner	Wrought-iron gate		963.00	Do.
Oct. 10	Cranford Paving Co	Waterproofing and asphalt paving	Waterproofing, 18 cents per square foot; asphalt paving, 18 cents per square foot.	2,936.16	Do.
Oct. 23	Snead & Co. Iron Works	Steel floor plates	52 cents per square foot	2,438.80	Do.
Oct. 24	Vermont Marble Co	Marble-work		41,757.00	In force.
Oct. 24	Chas. B. Nichols	Filling and polishing wood-block flooring	80 cents per 100 square feet	1,208.04	Completed.
Nov. 18	Cranford Paving Co	Granolithic and binder	Granolithic, $2.37 per cubic yard; binder, $2.17 per cubic yard.	746.64	Do.
Nov. 20	Charles E. Ellicott	Castings		551.09	Do.
Nov. 21	Holophane Glass Co	Holophane globes		1,200.00	Do.
Nov. 21	The De Kosenko Manufacturing Co	Electric lighting fixtures		8,834.65	In force.
Nov. 24	Snead & Co. Iron Works	Bronze door and lamp standards	Door, $6,540; lamp standards, 3,895	10,435.00	Do.
Nov. 25	H. T. Paiste Co	Electrical supplies		2,655.00	Completed.
Nov. 25	Charles E. Ellicott	Rosette plates		1,441.26	Do.
Nov. 26	Walter A. Hearn	Cleaning windows		216.65	Do.
Dec. 3	General Electric Co	Porcelain cut-outs	32½ cents each	650.00	Do.
Dec. 4	Western Electric Co	Electrical supplies		889.00	Do.

List of all contracts which have been let from the beginning of the work to the present time—Continued.

Date.	Name of contractor.	Subject of contract.	Price.	Actual or estimated total.	Present condition.
1902.					
Dec. 10	John P. Agnew & Co	Coal (bituminous)	$5.50 per ton	$1,658.80	Completed.
Dec. 11	Otis Elevator Co	Elevators	Supplementary to contract of Nov. 29, 1901, changing terms of payment.		In force.
Dec. 12	Snead & Co. Iron Works	Freight elevator door frames		10,938.00	Do.
Dec. 16	The De Kosenko Manufacturing Co	Column fixtures		14,740.10	Completed.
1903.					
Jan. 21	Baltimore Iron Works	Press pits		1,782.50	Do.
Jan. 21	do	Paper chute		785.50	Do.
Jan. 29	Jas. G. Wilson	Replaning wood-block floors		1,579.45	Do.
Jan. 30	New Jersey Foundry and Machine Co	Steel doors		1,749.00	Do.
Mar. 30	do	Fireproof doors	Supplementary to contract of Mar. 19, 1902	1,040.00	Do.
Apr. 17	Geo. B. Clopp	Form-lift inclosures		2,349.00	In force.
Apr. 21	Perry & Whitney Co	Interior decoration		10,975.00	Do.
Apr. 23	Sterling Bronze Co	Changing finish on elevator inclosures and cages.		3,120.00	Do.
May 6	Albert & J. M. Anderson Manufacturing Co.	Panel boards		765.00	Do.
June 5	Miles Pneumatic Tube Co	Pneumatic-tube system		16,709.00	Do.
June 30	E. Garet	Model of building		1,500.00	Do.
	Total amount of contracts made			1,770,506.67	

In closing, I wish to renew the expression of my appreciation of my office and field forces, including especially all the individuals mentioned in my last annual report. I desire also to express my appreciation of the uniform courtesy experienced at the hands of Hon. F. W. Palmer, Public Printer.

Very respectfully, your obedient servant,

JOHN STEPHEN SEWELL,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

APPENDIX J J J.

OPERATIONS ON BUILDINGS, ARMY WAR COLLEGE, WASHINGTON, D. C., AND ENGINEER SCHOOL, WASHINGTON, D. C.

REPORT OF CAPT. JOHN S. SEWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

United States Engineer Office for
Reconstruction of Washington Barracks,
Washington Barracks, Washington, D. C., July 20, 1903.

General: I have the honor to submit the following report of operations on the reconstruction of Washington Barracks, D. C., for the fiscal year ending June 30, 1903:

BUILDINGS, ARMY WAR COLLEGE.

Work on the design of the War College building was taken up by the architects in July and August, 1902. The general design was practically completed before January 1, 1903. Meantime some investigations had been made as to the probable nature of the foundations at the site of the War College building. Examination of old structures which occupied a part of this site seemed to indicate that there would be no special difficulty and that foundations of the ordinary type at ordinary depths would be quite sufficient to carry the building.

The actual excavation at the easterly end of the War College building confirmed this conclusion; at the west end conditions were not so favorable. The ground here was composed in part of a deep mud fill in an old inlet from the river. It was necessary at this end to excavate to a depth of as much as 18 feet to find a solid foundation.

On February 21, 1903, the northeast corner stone of the building was laid with Masonic ceremonies. A contract had been let with The Norcross Brothers Company for the granite base course, of which the granite corner stone was part. All of this granite has been delivered during the fiscal year.

The foundations at the west end of the building, over about 40 per cent of its area, have been nearly completed. A considerable quantity of granite base course has been put in place on top of the concrete foundation walls, and the northwest corner stone has been set.

A sewer for discharging the drainage of the War College building into the river has also been completed from its outfall to the building line.

The following amount of work has been completed:

Total excavation to date, 1,637 cubic yards.
Total concrete placed to date, 1,030 cubic yards.
Total terra-cotta pipe (all sizes) used, 568 feet.

The present condition of the appropriation is as follows:

Amount appropriated by act of June 30, 1902		$400,000.00
June 30, 1903, amount expended to date		28,311.15
July 1, 1903, balance unexpended		371,688.85
July 1, 1903, outstanding liabilities	$11,105.74	
July 1, 1903, covered by existing contracts	43,563.80	
		54,669.54
July 1, 1903, balance available		317,019.31

The following is a list of all contracts which have been let from the beginning of the work to the present time:

List of all contracts let from beginning of work to present time.

Date.	Name of contractor.	Subject of contract.	Price.	Actual or estimated cost.	Present condition.
1902.					
Aug. 13	McKim, Mead & White	Architectural services		$14,000.00	In force.
Oct. 1	Wm. J. Baldwin	Designing heating plant		2,500.00	Do.
Nov. 22	Washington Brick and Terra Cotta Co	Common brick	$7.97 per thousand	23,910.00	Do.
Dec. 30	The Norcross Brothers Co	Granite base	Molded, $15.90 per linear foot; plain, $7.45 per linear foot.	13,680.01	Completed.
1903.					
May 27	S. Dana Lincoln	Portland cement	$1.89 per barrel	3,150.00	In force.
May 27	Do	Natural cement	87 cents per barrel	1,450.00	Do.
May 27	Atlas Portland Cement Co	Portland cement	$1.97 per barrel	3,300.00	Do.
May 28	Columbia National Sand Dredging Co	Sand and gravel	$1.25 per cubic yard for building sand, concrete sand, and gravel.	6,000.00	Do.
	Total amount of contracts made			67,990.01	

BUILDINGS, ENGINEER SCHOOL.

Work on this post commenced in August, 1902, when a number of tests of the ground were made to determine the kind of foundations that would be necessary. The sites of the various buildings were located and cleared of trees, etc. Final revised plans of barracks and officers' quarters were received in the latter part of October, 1902, and in November, 1902, and work on foundations was begun. Owing to the irregular nature of the ground, which is quite solid at some places and a fill of river mud at others, different kinds of foundations were used. Where the ground is solid an ordinary foundation was constructed, but where the ground is a fill of river mud which is liable to dry out, concrete piles were resorted to. In some places the character of the ground changes very suddenly, as at the site of the east barrack. The east half and the west end of this building are on solid clay, and the remainder of the west half is over a fill of soft river mud which is about 40 feet deep in places below the permanent floor. Constructing foundations in this material was tedious and laborious. At the end of the fiscal year the most of this foundation work was completed, although some work still remains. Brickwork at the east end of this barrack had been carried up to the window sill levels of the basement. Plans for the band barracks and company mess halls were received the latter part of April, 1903. The former building had to be built on piles, and the pile driver commenced work in May, 1903. At the end of the fiscal year the excavation for the mess halls and east half of the west barrack were about completed. The latter building can only be built in part until the general hospital here can be removed, as the hospital stands on part of the site of the barrack.

This hospital is not only inadequate in size, but entirely unsuitable in its character of construction for the purposes of a general hospital. It was cheaply built, as the amount of money available for its construction was very limited. It is not fireproof and is therefore insanitary. The timber floor joists and studding have shrunk and caused cracks in places to such an extent that it would be impossible to keep the building in a thoroughly sanitary condition with any reasonable effort, or at any reasonable expense. The presence of the building in its present location will seriously delay the completion of the work at the engineer school. If in any way it is possible to expedite the removal of this old hospital building, it should be done. A modern hospital, especially one of the character of this, should always be built of the highest class of fireproof material, not so much on account of the danger of fire, but because fireproof construction does not shrink and crack. For this reason it is possible to keep such a building clean and in sanitary condition, whereas such a thing is impossible with a building of nonfireproof construction. The space available at Washington Barracks is entirely too contracted to give the necessary room for a general hospital, besides which the location is not favorable for such purposes, as it is too low and too near the river. The presence of the old hospital building, and the consolidation of the material which is now being pumped into the post for filling will be the ruling factors in determining the time within which the work of reconstruction of Washington Barracks can be finished. In some places where important buildings are to be erected, the fill is now so soft that it would be impossible to conduct building operations, and the consolidation seems to proceed quite slowly. Even if Congress authorized a general hospital at the next session it would

probably be several years before the present one could be abandoned. From present prospects the consolidation of the fill will consume an equal length of time. Barring such impediments as these, the work of reconstruction of Washington Barracks should not consume more than two years in ordinary conditions of the building market, but because of the great activity in the building trades, and the consequent difficulty in securing labor and materials, and especially because of the delay likely to be caused by the general hospital and the filling, it is impossible to say just how long it will take to complete this work in all of its details. It is probable, however, that it can be practically completed in a little more than two years.

The two frame barrack buildings used for the Hospital Corps at Washington Barracks occupy space which is to be devoted eventually to two sets of officers' quarters. The general hospital itself interferes with the west half of Barrack No. 2. Even if this half of the barrack building and the two sets of officers' quarters have to be delayed for some time it will not be a very serious matter, and probably the project can be completed, with the exception of these items, in a little more than two years. Operations are being pushed at the present time just as rapidly as conditions will permit.

The line of officers' quarters are well underway. Nine of them have been brought up to the first-story level and six have the first-story joist in place. All of them, except the two which are to be placed at the site of the frame hospital barracks, are progressing with reasonable rapidity.

The total number of brick laid up to the end of the fiscal year was about 379,000. The amount of brickwork is really the best indication of general progress.

The present condition of the appropriation is as follows:

Amount appropriated by act of June 30, 1902		$500,000.00
Amount appropriated by act of March 2, 1903		360,000.00
		860,000.00
June 30, 1903, amount expended to date		53,198.74
July 1, 1903, balance unexpended		806,801.26
July 1, 1903, outstanding liabilities	$8,833.21	
July 1, 1903, covered by existing contracts	87,107.27	
		95,940.48
July 1, 1903, balance available		710,860.78

The following is a list of all contracts which have been let from the beginning of the work to the present time:

List of all contracts from beginning of work to present time.

Date.	Name of contractor.	Subject of contract.	Price.	Actual or estimated cost.	Present condition.
1902.					
Aug. 13	McKim, Mead & White	Architectural services		$26,000.00	In force.
Oct. 21	Wm. J. Baldwin	Designing heating plant		2,500.00	Do.
Nov. 22	Washington Brick and Terra Cotta Co.	Common brick	$7.97 per thousand	23,910.00	Do.
1903.					
Jan. 16	The Cranford Paving Co	Driving holes for concrete piles			Do.
Mar. 5	Potomac Electric Power Co	Electric current	6 cents per 1,000 watt hours		Do.
Mar. 6	Chesapeake and Potomac Telephone Co.	Telephone service	$80 per annum		Do.
May 6	The C. J. McCubbin Co	Pipe, etc		1,625.00	Completed.
May 20	The Cranford Paving Co	Concrete pile points	65 cents per cubic foot		In force.
May 27	S. Dana Lincoln	Portland cement	$1.89 per barrel	6,200.00	Do.
May 27	do	Natural cement	87 cents per barrel	2,900.00	Do.
May 27	Atlas Portland Cement Co	Portland cement	$1.97 per barrel	6,550.00	Do.
May 28	Columbia National Sand Dredging Co	Sand and gravel	$1.25 per cubic yard	12,000.00	Do.
June 29	Thomas R. Riley	Lumber	Virginia pine, $15.50 per M board feet, Georgia pine, $28.50 per M board feet.	9,481.24	Do.
June 30	Washington Granite Monumental Co	Stone sills, etc		5,567.76	Do.
(a)	Martin Wiegand	Door frames, etc		10,000.00	Do.
	Total amount of contracts made			106,734.00	

a Contract papers in process of execution.

Very respectfully, your obedient servant,

JOHN STEPHEN SEWELL,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

APPENDIX K K K.

CONSTRUCTION OF MILITARY ROAD FROM FORT WASHAKIE TO MOUTH OF BUFFALO FORK OF SNAKE RIVER, WYOMING.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

UNITED STATES ENGINEER OFFICE,
Yellowstone Park, Wyo., July 17, 1903.

GENERAL: I have the honor to transmit herewith report upon military road from Fort Washakie, Wyo., to mouth of Buffalo Fork of Snake River, for the fiscal year ending June 30, 1903.

Very respectfully, your obedient servant,

H. M. CHITTENDEN,
Captain, Corps of Engineers

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

REPORT OF CONSTRUCTION OF MILITARY ROAD FROM FORT WASHAKIE TO MOUTH OF BUFFALO FORK OF SNAKE RIVER, WYOMING.

The remaining balance of the appropriation was expended during the month of August, 1902, in general improvement work along the existing line, most of the work being done near the east end. The work presented no features meriting particular mention.

As there is not likely to be any further appropriation for this work, it may be regarded as closed and this the final report upon it.

Money statement.

July 1, 1902, balance unexpended	$1,614.90
June 30, 1903, amount expended during fiscal year	1,614.90

APPENDIX L L L.

MONUMENTS TO GENERALS FRANCIS NASH AND WILLIAM LEE DAVIDSON, OF NORTH CAROLINA.

REPORT OF CAPT. E. EVELETH WINSLOW, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

(For letter of transmittal see Appendix N.)

Sites in the Guilford battle grounds, near Greensboro, N. C., have been selected by the governor of the State of North Carolina and approved by the Secretary of War.

Designs for the monuments are under consideration.

Money statements.

MONUMENT TO GENERAL DAVIDSON.

Amount appropriated by joint resolution of Congress approved January 30, 1903	$5,000.00
June 30, 1903, amount expended during fiscal year	22.33
July 1, 1903, balance unexpended	4,977.67

MONUMENT TO GENERAL NASH.

Amount appropriated by joint resolution of Congress approved January 30, 1903	$5,000.00
June 30, 1903, amount expended during fiscal year	22.33
July 1, 1903, balance unexpended	4,977.67

LAWS

AFFECTING

THE CORPS OF ENGINEERS,

UNITED STATES ARMY,

FIFTY-SEVENTH CONGRESS, SECOND SESSION,

1902-1903.

LAWS

AFFECTING

THE CORPS OF ENGINEERS, UNITED STATES ARMY,

FIFTY-SEVENTH CONGRESS, SECOND SESSION,

1902–1903.

PUBLIC ACTS.

December 17, 1902.

Vol. 32, p. 754.

CHAP. 3.—An Act To authorize the construction of a bridge across the Missouri River, at a point to be selected, within five miles north of the Kaw River, in Wyandotte County, State of Kansas, and Clay County, State of Missouri, and to make the same a post route.

Missouri River.

Kansas City Outer Belt and Electric Railroad Company may bridge, between Kansas and Missouri.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Kansas City Outer Belt and Electric Railroad Company, a corporation organized under the laws of the State of Kansas, and authorized by the laws of the State of Missouri to locate and construct its railway into and through Clay County, in said State, is hereby authorized to construct and maintain a bridge across the Missouri River on such line as its railway may hereafter be located in the county of Wyandotte, in the State of Kansas, and in the county of Clay, in the State of Missouri, and also to construct accessory works to secure the best practicable channel way for navigation and confine the flow of water to a permanent channel at such point, and also to lay on and over such bridge a railway track or tracks and other appliances for the more perfect connection of its railway when constructed to said river; and said corporation, its successors and assigns, may construct and maintain ways for wagons, carriages, and electric or other cars for carrying passengers, or passageways for foot passengers, charging and receiving reasonable toll therefor, as may be approved from time to time by the Secretary of War.

Location.

Channel.

Railway, wagon, and foot bridge.

Toll.

Construction.

SEC. 2. That any bridge built under the provisions of this Act may, at the option of the said railroad company, its successors or assigns, be built as a drawbridge or with unbroken and continuous spans: *Provided*, That if the same shall be made of unbroken and continuous spans it shall not be in any case of less elevation than fifty feet above high-water mark, as registered since the year eighteen hundred and seventy, as understood at the point of location, to the lowest point of the superstructure, with straight

Provisos.

High bridge.

girders; nor shall the main channel span of said bridge be less than four hundred feet in the clear at low-water mark, and all other spans over the waterway shall be not less than three hundred feet in the clear; and the piers of the said bridge shall be parallel with the current of the river, and the bridge itself at right angles thereto as near as may be, and the main span shall be over the main channel of the river: *And provided also*, That if a bridge shall be built under this Act as a drawbridge the same shall be constructed as a pivot drawbridge with one or more draws, as the Secretary of War may prescribe, and with spans of such clear length on each side of the central or pivot piers of the draws as he may prescribe; and the next adjoining spans over the river to the draws shall also be of such clear length as he may prescribe; and said spans shall not be less than ten feet above extreme high-water mark, as registered since the year eighteen hundred and seventy, measuring to the lowest part of the superstructure of the bridge; and the piers of the said bridge shall be parallel with the current of the river, and the bridge itself at right angles thereto as near as may be: *And provided also*, That said drawbridge shall be opened promptly upon reasonable signal and without unnecessary delay: *Provided*, That said company, its successors and assigns, shall maintain, at its own expense, from sunset until sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe, and shall build and maintain such sheer booms or other structures as may be necessary to safely guide vessels, rafts, or other water craft through said channel spans and as shall receive the approval of the Secretary of War: *And provided further*, That the company, person, or corporation building said bridge may, subject to the approval of the Secretary of War, enter upon the banks of said river, either above or below the point of location of said bridge, and confine the flow of the water to a permanent channel and to do whatever may be necessary to accomplish said object, but shall not impede or obstruct the navigation or flood discharge of said river, and shall be liable for all injuries to or appropriation of private property; and all plans for such works or erections upon or within the banks of the river shall be submitted to the Secretary of War for his approval before any of such work shall have been commenced.

Drawbridge.

Opening draw.

Lights, etc.

Permanent channel.

Secretary of War to approve plans, etc.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which shall substantially or materially obstruct the free navigation of said river, and no bridge shall be commenced or built under this Act until the location thereof and the plans and specifications for its construction, with such maps as shall be necessary for a full understanding of the regimen of the river for a distance of one mile above and one-half mile below the proposed site of the bridge, shall have been submitted to and approved by the Secretary of War; and any change in the plan of such construction or any alteration in the bridge after its construction shall be subject to the like approval; and whenever said bridge shall, in the opinion

Changes.

of the Secretary of War, substantially obstruct the free navigation of said river, he is hereby authorized to cause such change or alteration of said bridge to be made as will obviate such obstruction, and all such alterations shall be made and all such obstructions shall be removed at the expense of the owner or owners of said bridge or the persons operating or controlling the same; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of the Missouri River, at or near the crossing of said bridge, caused thereby, the cause shall be commenced and tried in the circuit court of the United States of either judicial district of the States of Kansas or Missouri in which said bridge or any portion of such obstruction touches.

Litigation.

SEC. 4. That the said bridge and accessory works, when built and constructed under this Act and according to the terms and limitations thereof, shall be a lawful structure; and said bridge shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States or for passengers and freight passing over said bridge than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post routes in the United States.

Lawful structure and post route.

SEC. 5. That the United States shall have the right of way for such postal-telegraph and telephone lines across said bridge as the Government may construct or control, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies.

Telegraph, etc., rights.

SEC. 6. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same and over the approaches thereto upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War, upon a hearing of the allegations and proofs of the parties: *Provided*, That the provisions of section four in regard to charges for passengers and freight across said bridge shall not govern the Secretary of War in determining any question arising as to the sum or sums to be paid to the owners of said bridge by said companies for the use of said bridge.

Use by other companies.

Compensation.

Secretary of War to adjust disputes.

Proviso.
Charges.
Supra.

SEC. 7. That Congress may, at any time, alter, amend, or repeal this Act.

Amendment.

SEC. 8. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within two years and completed within four years from the date of the approval of this Act.

Time of construction.

Approved, December 17, 1902.

December 22, 1903. Vol. 32, p. 758.

CHAP. 10.—An Act Making appropriations to supply urgent deficiencies in the appropriations for the fiscal year ending June thirtieth, nineteen hundred and three.

Urgent deficiencies appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, to supply deficiencies in the appropriations for the fiscal year nineteen hundred and three, namely:

* * * * *

War Department.

WAR DEPARTMENT.

Buildings and grounds.

BUILDINGS AND GROUNDS IN AND AROUND WASHINGTON.

Sherman statue.

For extra steps and mosaic work at the base of the Sherman statue pedestal, and for each and every purpose connected therewith, eight thousand dollars.

* * * * *

Approved, December 22, 1902.

December 23, 1902. Vol. 32, p. 760.

CHAP. 12.—An Act To authorize the construction of a bridge across the Savannah River at Sand Bar Ferry, below the city of Augusta, Georgia.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That B. W. Fair, his heirs and assigns, are hereby authorized to build and maintain a bridge across the Savannah River, at such point as may be selected by him and approved by the Secretary of War, at or near the present location of Sand Bar Ferry, where the public road leading from Augusta, Georgia, to Beach Island, South Carolina, crosses the river, the bridge to be so constructed as not to interfere with the navigation of the river.

Savannah River, Ga.

B. W. Fair may bridge, at Sand Bar Ferry.

Unobstructed navigation. Location.

SEC. 2. That the bridge authorized under this Act shall be located on the land of said B. W. Fair, and shall be constructed under and remain subject to such regulations for the security of the navigation of the river as the Secretary of War shall prescribe; and to secure that object the said B. W. Fair, his heirs or assigns, shall submit to the Secretary of War, for his examination and approval, a design and drawing of the proposed bridge and a map of the location, giving, for the space of at least one-quarter mile above and one-quarter mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, and the direction and strength of the current and the soundings, accurately showing the bed of the stream, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until said plan and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plan of said bridge during the progress of construction or after its completion such change shall be subject to the approval of the Secretary of War.

Secretary of War to approve plans, etc.

Map.

Changes.

SEC. 3. That the bridge constructed under this Act shall be a lawful structure and shall be recognized and known as a post route, upon which no higher charge shall be made for the transportation over the same of the mails, the troops, and the munitions of war of the United States than the charge usually made for similar service to the public generally; and the United States shall have the right of way for a postal telegraph across said bridge; and said structure shall be so kept and managed at all times as to afford reasonable and proper means for the passage of vessels through or under said bridge; and for the safety of vessels passing at night there shall be displayed on said bridge, from sunset to sunrise, at the expense of the owners thereof, such lights and other signals as may be prescribed by the Light-House Board; and the said bridge shall be changed or altered at the cost and expense of the owners thereof from time to time, as the Secretary of War may direct, so as to preserve the free and convenient navigation of said river.

Lawful structure and post route.

Telegraph, etc., rights.

Lights, etc.

SEC. 4. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the approval of this Act.

Time of construction.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby reserved.

Amendment.

Approved, December 23, 1902.

CHAP. 58.—An Act Authorizing the Federal Railroad Company to construct a combined railroad, wagon, and foot-passenger bridge across the Missouri River at or near the village of Oacoma, Lyman County, South Dakota.

January 8, 1903.

Vol. 32, p. 762.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Federal Railroad Company, a corporation duly created and existing under the laws of the State of South Dakota, its successors or assigns, be, and they are hereby, authorized to construct and maintain a bridge and approaches thereto over the Missouri River from a point at or near the village of Oacoma, in the county of Lyman and State of South Dakota, to the opposite shore of said river, in the county of Brule, State of South Dakota: *Provided*, That a location within such limits is found suitable to the interests of navigation. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of said corporation, its successors or assigns, may be so constructed to provide for and be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for reasonable rates of toll, to be fixed by said corporation, its successors or assigns, and approved by the Secretary of War, and the Secretary of War shall have the right from time to time to revise such rates of toll: *Provided*, That the bridge herein authorized to be constructed shall not be built within less than one mile from any other bridge across said Missouri River.

Missouri River.
Federal Railroad Company may bridge at Oacoma, S. Dak.

Provisos.
Protection to navigation.

Railway, wagon, and foot bridge.

Toll.

Location.

Construction.

SEC. 2. That any bridge built under the provisions of this Act may, at the option of the corporation building the same, be built as a drawbridge, or with unbroken or continuous spans: *Provided*, That if the same shall be made of unbroken or continuous spans, it shall not be in any case of less elevation than fifty feet above the high-water mark, as understood at the point of location, to the lowest part of the superstructure; nor shall the spans of said bridge be less than three hundred feet in the clear at low-water mark, and the piers of said bridge shall be parallel with the current of the river at high water, and the main span shall be over the main channel of the river: *And provided also*, That if a bridge shall be built under this Act as a drawbridge, the same shall be constructed as a pivot drawbridge, with one or more draws, as the Secretary of War may prescribe, and of spans of not less than two hundred feet in length in the clear on each side of the central or pivot piers of the draws, and the next adjoining spans over the river to the draws shall not be less than two hundred and fifty feet in the clear, measured at low water; and said spans shall not be less than ten feet above extreme high-water mark, measuring to the lowest part of the superstructure of the bridge; and the piers of said bridge shall be parallel with the current of the river at high water: *And provided also*, That said draw shall be opened promptly upon reasonable signal, without unnecessary delay; and said company or corporation shall maintain at its own expense, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe, and such sheer booms or other structures as may be necessary to guide vessels, rafts, or other water craft safely through said channel spans or draw openings, and as shall be designated and required by the Secretary of War: *And provided further*, That the corporation building said bridge may, subject to the approval of the Secretary of War, enter upon the banks of said river, above or below the location of said bridge, and confine the flow of the water to a permanent channel, and do whatever may be necessary to accomplish this object, but shall not impede or obstruct the navigation of said river, and shall be liable in damages for all injuries to private property; and all plans for such works or erections upon the banks of the river shall be first submitted to the Secretary of War for his approval: *And provided further*, That any bridge built under the provisions of this Act shall be at right angles to the current of the river at high water.

Provisos. High bridge. Drawbridge. Lights, etc. Permanent channel. Aids to navigation.

Secretary of War to approve plans, etc.

SEC. 3. That no bridge shall be erected or maintained under the authority of this Act which will at any time substantially or materially interfere with the free navigation of said river; and no bridge shall be commenced or built under this Act until the location thereof and the plans and specifications for its construction shall have been submitted to and approved by the Secretary of War; and any change in the plans of such construction or any alteration in the bridge after its construction shall be subject to like approval; and whenever said bridge or its

Changes.

accessory works shall, in the opinion of the Secretary of War, unreasonably obstruct the free navigation of said river he is hereby authorized to cause such change or alteration to be made as will effectually obviate such obstruction; and all such alterations shall be made and all such obstructions shall be removed at the expense of the owner or owners of said bridge or the persons operating or controlling the same; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said Missouri River at or near the crossing of said bridge, caused or alleged to be caused thereby, the cause shall be commenced and tried in the circuit courts of the United States of either judicial district of South Dakota in which the said bridge or any portion of such obstruction touches. And the bridge shall not be opened to traffic until all piling and other false work used in constructing the bridge shall have been wholly removed to the satisfaction of the Secretary of War.

Litigation.

SEC. 4. That any bridge built under this Act and according to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transportation over the same of the mails, troops, and munitions of war of the United States than the rate per mile paid for their transportation over the railroad or public highways leading to such bridge. The United States shall also have the right to construct, without charge therefor, telegraph or telephone lines across said bridge. And all railroad companies desiring to use said bridge shall have and be entitled to equal rights and privileges in the passage of the same, and in the use of the machinery and fixtures thereof, and of all the approaches thereto, under and upon such terms and conditions as shall be prescribed by the Secretary of War, upon hearing the allegations and proofs of the parties, in case they shall not agree; and equal rights and privileges in the use of said bridge shall be granted to all telegraph and telephone companies.

Lawful structure and post route.

Use by other companies. Compensation, etc.

Telegraph, etc., privileges.

SEC. 5. That Congress may at any time alter, amend, or repeal this Act.

Amendment.

SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within two years and completed within four years from the date hereof.

Time of construction.

Approved, January 8, 1903.

CHAP. 87.—An Act To authorize and empower the Southwest Louisiana Rice Growers' Association, of the State of Louisiana, to construct a lock or locks and a dam in Bayou Vermilion, in the State of Louisiana.

January 10, 1903.

Vol. 32, p. 766.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Southwest Louisiana Rice Growers' Association, of the State of Louisiana, be, and is hereby, authorized to construct a lock or locks and a dam near the mouth of Bayou Vermilion, or at some suitable point in said bayou,

Bayou Vermilion, La. Southwest Louisiana Rice Growers' Association may construct dam, etc., in.

Provisos. Payment of cost. Secretary of War to approve plans, etc.

to be approved by the Secretary of War: *Provided*, That said lock or locks and a dam shall be constructed and paid for by said association. The examination and surveys for the construction of said lock or locks and a dam, and the construction of the same, shall be subject to the supervision of the United States engineers and done in accordance with plans and specifications to be furnished by said association and approved by the Secretary of War.

Construction.

The work on said lock or locks and a dam may commence as soon as said association shall judge proper after the survey provided for above shall have been made and plans and specifications for said lock or locks and a dam shall have been approved by the Secretary of War.

Maintenance. Unobstructed navigation.

The maintenance of said lock or locks and a dam shall devolve on said association, which shall at all times keep same in proper condition and so as not to interfere with the free navigation of said bayou; nor shall said association at any time impose any toll for the passage of any craft through said lock or locks: *Provided further*, That such suitable fishways as may be prescribed by the United States Fish and Fisheries Commission shall be provided in the said dam by the said association.

Fishways.

Time limit.

SEC. 2. That this Act shall be null and void unless the privilege hereby granted shall be availed of within two years from the date hereof.

Amendment.

SEC. 3. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, January 10, 1903.

January 10, 1903.
Vol. 32, p. 766.

CHAP. 88.—An Act To authorize and empower the Rice Irrigation and Improvement Association, of the State of Louisiana, to construct a lock or locks and a dam in Mermentau River, in the State of Louisiana.

Mermentau River, La. Rice Irrigation and Improvement Association may construct dam, etc., in.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Rice Irrigation and Improvement Association, of the State of Louisiana, be, and is hereby, authorized to construct a lock or locks and a dam near the mouth of Mermentau River or at some suitable point in said river, to be approved by the Secretary of War: *Provided*, That said lock or locks and a dam shall be constructed and paid for by said association. The examination and surveys for the construction of said lock or locks and a dam, and the construction of the same, shall be subject to the supervision of the United States Engineers and done in accordance with plans and specifications to be furnished by said association, and approved by the Secretary of War. The work on said lock or locks and a dam shall commence as soon as said association shall judge proper after the survey provided for above shall have been made, and plans and specifications for said lock or locks and a dam shall have been approved by the Secretary of War. The maintenance of said lock or locks and dam shall devolve on said association, which shall at all times keep same in a

Provisos. Payment of cost. Secretary of War to approve plans, etc.

Construction.

Maintenance. Unobstructed navigation.

proper condition and so as not to interfere with free navigation of said river; nor shall said association, at any time, impose any toll for the passage of any craft through said lock or locks: *Provided further*, That such suitable fish ways as may be prescribed by the United States Commission of Fish and Fisheries shall be provided in the said dam by the said association. Fishways.

SEC. 2. That this Act shall be null and void unless the privilege hereby granted shall be availed of within two years from the date hereof. Time limit.

SEC. 3. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment.

Approved, January 10, 1903.

CHAP. 188.—An Act To authorize the Pensacola, Alabama and Tennessee Railway Company to erect, maintain, and operate a railway bridge across the Alabama River in Wilcox County, in the State of Alabama. January 15, 1903. Vol. 32, p. 772.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Pensacola, Alabama and Tennessee Railway Company, a railroad corporation organized under the laws of the States of Florida and Alabama, its successors and assigns, are hereby authorized and empowered to erect, establish, maintain, and operate a railway bridge across the Alabama River at such point in Wilcox County, State of Alabama, as may be by said company selected and approved by the Secretary of War; and if said bridge erected and maintained under the authority of this Act shall at any time unreasonably obstruct the free navigation of said river, or shall, in the opinion of the Secretary of War, unreasonably obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction; and such alteration shall be made and all such obstructions be removed at the expense of the owners or operators of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to free navigation of said river by reason of the construction of said bridge, the same shall be instituted and determined in the district court of the United States for the southern district of Alabama: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the navigation of rivers, or to exempt this bridge from the operation of the same.

Alabama River, Ala. Pensacola, Alabama and Tennessee Railway Company may bridge. Location. Unobstructed navigation. Changes. Litigation. *Proviso.* Existing laws not affected.

SEC. 2. That the bridge authorized to be constructed under this Act shall be located and built subject to such regulations for security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company shall submit to the Secretary of War, for his examination and approval, a general design and drawing of said bridge and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, soundings showing

Secretary of War to approve plans, etc.

the bed of the stream, and such other information as the Secretary of War may require for a full and satisfactory understanding of the subject; and until the plan and location of the bridge are approved by the Secretary of War the construction of said bridge shall not be commenced.

Lights, etc.

SEC. 3. That the draw of the bridge herein authorized to be constructed shall be opened promptly upon reasonable signal for the passing of boats, and such lights or signals as the Light-House Board shall prescribe shall be displayed, from sunset until sunrise, on said bridge by the owners thereof at their own expense.

Use by other companies.

Compensation.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same, and over the approaches thereto, upon payment of a reasonable compensation for such use; and in case of disagreement between the parties in regard to the compensation to be paid, or the conditions to be observed, all matters at issue shall be determined by the Secretary of War.

Lawful structure and post route.

Telegraph, etc., privileges.

SEC. 5. That the bridge to be built under this Act and according to its limitations shall be held to be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for transportation over the same of the mails, troops, and munitions of war of the United States than the rate per mile paid for their transportation over the railroad leading to such bridge; and it shall enjoy the rights and privileges of other post roads in the United States; and the United States shall have the right of way across said bridge and its approaches for postal-telegraph purposes; and all telegraph and telephone companies shall have equal right and privileges in constructing and maintaining their lines across said bridge.

Time of construction.

SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of the approval of this Act.

Amendment.

SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, January 15, 1903.

January 21, 1903.

Vol. 32, p. 775.

CHAP. 196.—An Act To promote the efficiency of the militia and for other purposes.

Militia. Composition of.

National Guard.

Reserve Militia.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the militia shall consist of every able-bodied male citizen of the respective States, Territories, and the District of Columbia, and ever able-bodied male of foreign birth who has declared his intention to become a citizen, who is more than eighteen and less than forty-five years of age, and shall be divided into two classes—the organized militia, to be known as the National Guard of the State, Territory, or District of Columbia, or by such other designations as may be given them by the laws of the respective States or Territories, and the remainder to be known as the Reserve Militia.

* · * * * *

SEC. 17. That the annual appropriation made by section sixteen hundred and sixty-one, Revised Statutes, as amended, shall be available for the purpose of providing for issue to the organized militia any stores and supplies or publications which are supplied to the Army by any department. Any State, Territory, or the District of Columbia may, with the approval of the Secretary of War, purchase for cash from the War Department, for the use of its militia, stores, supplies, material of war, or military publications, such as are furnished to the Army, in addition to those issued under the provisions of this act, at the price at which they are listed for issue to the Army, with the cost of transportation added, and funds received from such sales shall be credited to the appropriations to which they belong and shall not be covered into the Treasury, but shall be available until expended to replace therewith the supplies sold to the States and Territories and to the District of Columbia in the manner herein provided.

Issue of army stores, etc.
R. S., sec. 1661, p. 290.

Purchase of additional supplies, etc.

Use of receipts from sales.

* * * * *

Approved, January 21, 1903.

CHAP. 397.—An Act To authorize the construction of a bridge across the Clinch River, in the State of Tennessee, by the Knoxville, Lafollette and Jellico Railroad Company.

February 3, 1903.
Vol. 32, p. 793.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Knoxville, Lafollette and Jellico Railroad Company, a corporation created and organized under the laws of the State of Tennessee, be, and it is hereby, authorized to construct and maintain a bridge and approaches thereto over the Clinch River, in the State of Tennessee, at or near Dossett, Tennessee.

Clinch River, Tenn.
Knoxville, Lafollette and Jellico Railroad may bridge at Dossett.

SEC. 2. That said bridge shall be constructed for the passage of railway trains, and shall be a lawful structure, and shall be recognized and known as a post route, upon which no higher charge shall be made for the transmission over the same of the mails, the troops, and munitions of war of the United States than the rate per mile paid for the transportation over the railroads leading to the said bridge, and shall enjoy the rights and privileges of other post-roads in the United States, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal telegraph and telephone purposes.

Lawful structure and post route.

Telegraph, etc., rights.

SEC. 3. That said bridge shall be built and located under and subject to such regulations for the security of navigation of such river as the Secretary of War shall prescribe; and to secure that object the company building the said bridge shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location thereof, and until the said plan and location are approved by the Secretary of War the

Secretary of War to approve plans, etc.

Changes. said bridge shall not be commenced or built, and no changes shall be made in said bridge during the progress of construction, or after completion, unless approved by the Secretary of War; and the said company shall, at its own expense, make from time to time such changes in said bridge as the Secretary of War may order in the interests of navigation: *Provided*, That if said bridge shall be built as a drawbridge the draw shall be opened promptly upon reasonable signal for the passage of all water craft; and upon whatever kind of bridge is constructed the said company shall maintain, at its own expense, from sunset to sunrise, such lights or other signals as the Light-House Board may prescribe.

Proviso. Opening draw.

Lights, etc.

Use by other companies. Compensation.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges in the passage of railroad trains over the same and the approaches thereto upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies or any one of them desiring such use shall fail to agree upon the sum or sums to be paid and upon the rules and conditions to which each shall conform in the use of said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proof of the parties.

Time of construction.

SEC. 5. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within two years from the date of the approval of this Act.

Amendment.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, February 3, 1903.

February 7, 1903.

Vol. 32, p. 801.

CHAP. 512.—An Act To provide for the construction of a bridge across Rainy River in Minnesota.

Rainy River, Minn.

International Bridge and Terminal Company may bridge. Location.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the International Bridge and Terminal Company, a corporation duly organized under the laws of the State of Minnesota, its successors and assigns, be, and the same hereby is, authorized and empowered to construct and maintain a bridge over the Rainy River at the head of the falls in the river, in section twenty-seven, in township seventy-one north, of range twenty-four west, of the fourth principal meridian, in the county of Itasca and State of Minnesota: *Provided*, That the plan, location, and elevation of the bridge shall be subject to the approval of the Secretary of War, and until approved by him the bridge shall not be commenced or built.

Proviso. Secretary of War to approve plan, etc.

Lawful structure and post route.

SEC. 2. That any bridge built under this Act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transportation over the same of the mails, the troops, and munitions of war of

the United States than the rate per mile for the transportation over the railroads or public highways leading to the said bridge, and it shall enjoy the rights and privileges of other post-roads in the United States: *Provided*, That all railroad companies desiring the use of said bridge shall be entitled to equal rights and privileges in the passage of railroad trains over the same, and the approaches thereto, upon the payment of a reasonable compensation therefor, and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon the rules and conditions to which each shall conform in the use of said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal telegraph and telephone purposes.

Proviso. Use by other roads.

Compensation.

Telegraph, etc., rights.

SEC. 3. That if the Secretary of War shall find and determine that said bridge as actually located is situate at a point where said Rainy River is not actually navigable for boats, then the Secretary of War shall permit the construction of such bridge without a draw: *Provided, however*, That in that case if the river at the point of the location of such bridge shall in the future be rendered navigable for boats by the construction of a canal and lock, or otherwise, then the International Bridge and Terminal Company, its successors and assigns, shall reconstruct said bridge at its own expense with a draw, whenever directed so to do by the Secretary of War, upon plans and in accordance with specifications to be submitted for that purpose and to be first approved by the Secretary of War; and if in such case the International Bridge and Terminal Company, its successors and assigns, shall fail to proceed at once upon receiving such directions from the Secretary of War to reconstruct said bridge and to complete such reconstruction in accordance with such plans and specifications with all reasonable diligence, then it shall be the duty of the Secretary of War to remove such bridge.

Construction without a draw.

Proviso. Reconstruction of bridge to aid navigation.

Removal of bridge.

SEC. 4. That any bridge constructed under the authority of this Act, including any reconstruction thereof as provided for in the last section, shall be built and located and operated under and subject to such regulations for the security of the navigation of said river as the Secretary of War shall from time to time prescribe; and to secure that object the International Bridge and Terminal Company, its successors and assigns, shall submit to and file with the Secretary of War all designs, drawings, and maps of location of the bridge, and furnish such other information as may be required for a full and complete understanding of the subject; and the company, its successors and assigns, shall cause to be displayed on said bridge, from the hours of sunset to sunrise and at other times, such lights and other signals as may be prescribed by the Light-House Board.

Protection to navigation.

Map.

Lights, etc.

Opening draw. SEC. 5. That in case the Secretary of War shall direct that said bridge shall be constructed with a draw or draws such draw or draws shall be opened promptly upon reasonable signal for the passage of boats, vessels, or other water craft; and at the time of the erection of the piers, or whenever in the opinion of the Secretary of War the same may be necessary, the persons or corporations constructing, owning, or operating said bridge shall, at their own expense, construct proper sheer booms or other proper structures to safely guide boats, vessels, or other water craft through the said spans.

Booms, etc.

Time of construction. SEC. 6. That if the actual construction of the bridge hereby authorized shall not be commenced within two years from the date of the approval of this Act, and completed within five years after the same date, then this Act shall be void, and all rights hereby conferred shall cease and be determined; and that the construction shall not be commenced until the government of the Dominion of Canada has authorized the construction and maintenance of that part of said bridge which shall occupy that portion of the river which is under the jurisdiction of said Dominion government.

Construction within Canadian jurisdiction.

Amendment. SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, February 7, 1903.

February 7, 1903.

Vol. 32, p. 802.

CHAP. 513.—An Act Permitting the building of a dam across the St. Croix River at or near the village of St. Croix Falls, Polk County, Wisconsin.

St. Croix River, Wis.

St. Croix Falls Wisconsin Improvement Company may dam at St. Croix Falls.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of Congress is hereby granted to St. Croix Falls Wisconsin Improvement Company, a corporation organized under the laws of the State of Wisconsin, and to St. Croix Falls Minnesota Improvement Company, a corporation organized under the laws of the State of Minnesota, or either of them, their and each of their successors or assigns, to build a dam across the St. Croix River at or near the St. Croix Falls, so called, in said river, and all works incident thereto in the utilization of the power thereby developed: *Provided*, That the plans for the construction of said dam and appurtenant works shall be submitted to and approved by the Chief of Engineers and the Secretary of War before the commencement of the construction of such dam: *And provided further*, That said St. Croix Falls Wisconsin Improvement Company and said St. Croix Falls Minnesota Improvement Company, or either of them, their and each of their successors or assigns shall not deviate from such plans after such approval either before or after the completion of the structure, unless the modification of said plans shall have previously been submitted to and received the approval of the Chief of Engineers and of the Secretary of War: *And provided further*, That there shall be placed and maintained in connection with said dam a sluiceway so arranged as to permit logs, tim-

Provisos. Plans to be approved by the Secretary of War.

Construction of sluiceway.

ber, and lumber to pass around, through or over said dam, without unreasonable delay or hindrance, and without toll or charges; that the Government of the United States may, at any time, construct in connection therewith a suitable lock for navigation purposes, may at any time without compensation control the said dam for purposes of navigation, but shall not destroy the water power created by said dam to any greater extent than may be necessary to provide proper facilities for navigation; and that the Secretary of War may, at any time, require and enforce, at the expense of the owners, such modifications and changes in the construction of said dam and may make such regulations for the operation of said dam as he may deem advisable in the interests of navigation.

Aids to navigation.

Changes.

SEC. 2. That in case any litigation arises from the building of said dam or from the obstruction of said river by said dam or appurtenant works cases may be tried in the proper courts, as now provided for that purpose in the States of Wisconsin and Minnesota, and in the courts of the United States.

Litigation.

SEC. 3. That this Act shall be null and void unless the dam herein authorized be commenced within two years and completed within five years from the time of the passage of this Act.

Time of construction.

SEC. 4. That the right to amend or repeal this Act is hereby expressly reserved.

Amendment.

Approved, February 7, 1903.

CHAP. 553.—An Act To increase the efficiency of the Army.

February 14, 1903.

Vol. 32, p. 830.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby established a General Staff Corps, to be composed of officers detailed from the Army at large, under such rules as may be prescribed by the President.

Army.

General Staff Corps established.

SEC. 2. That the duties of the General Staff Corps shall be to prepare plans for the national defense and for the mobilization of the military forces in time of war; to investigate and report upon all questions affecting the efficiency of the Army and its state of preparation for military operations; to render professional aid and assistance to the Secretary of War and to general officers and other superior commanders, and to act as their agents in informing and coordinating the action of all the different officers who are subject under the terms of this Act to the supervision of the Chief of Staff; and to perform such other military duties not otherwise assigned by law as may be from time to time prescribed by the President.

Duties of.

SEC. 3. That the General Staff Corps shall consist of one Chief of Staff and two general officers, all to be detailed by the President from officers of the Army at large not below the grade of brigadier-general; four colonels, six lieutenant-colonels, and twelve majors, to be detailed from the corresponding grades in the Army at large, under such

Composition of.

rules for selection as the President may prescribe; twenty captains, to be detailed from officers of the Army at large of the grades of captain or first lieutenant, who while so serving shall have the rank, pay, and allowances of captain mounted. All officers detailed in the General Staff Corps shall be detailed therein for periods of four years, unless sooner relieved. While serving in the General Staff Corps, officers may be temporarily assigned to duty with any branch of the Army. Upon being relieved from duty in the General Staff Corps, officers shall return to the branch of the Army in which they hold permanent commission, and no officer shall be eligible to a further detail in the General Staff Corps until he shall have served two years with the branch of the Army in which commissioned, except in case of emergency or in time of war.

Term of service.

Temporary assignments.

Subsequent detail restricted.

Exceptions.

Chief of Staff. Duties of.

SEC. 4. That the Chief of Staff, under the direction of the President or of the Secretary of War, under the direction of the President, shall have supervision of all troops of the line and of the Adjutant-General's, Inspector-General's, Judge-Advocate's, Quartermaster's, Subsistence, Medical, Pay, and Ordnance departments, the Corps of Engineers, and the Signal Corps, and shall perform such other military duties not otherwise assigned by law as may be assigned to him by the President. Duties now prescribed by statute for the Commanding General of the Army as a member of the Board of Ordnance and Fortification and of the Board of Commissioners of the Soldiers' Home shall be performed by the Chief of Staff or other officer designated by the President. Acts and parts of Acts authorizing aids-de-camp and military secretaries shall not apply to general officers of the General Staff Corps.

Vol. 25, p. 489.
Vol. 22, p. 565.

Aids-de-camp and military secretaries.
R. S., secs. 1096-1098, p. 203.

Chief of Artillery to serve as additional member.

Rank, pay, etc.

SEC. 5. That the Chief of Artillery shall hereafter serve as an additional member of the General Staff and by and with the advice and consent of the Senate shall have the rank, pay, and allowances of a brigadier-general and when the next vacancy occurs in the office of brigadier-general of the line, it shall not be filled, and thereafter the number of brigadier-generals of the line, exclusive of the Chief of Artillery, shall not exceed fourteen; and the provisions of the foregoing sections of this Act shall take effect August fifteenth, nineteen hundred and three.

Number of brigadier-generals limited.

In effect August 15, 1903.

Approved, February 14, 1903.

February 18, 1903.

Vol. 32, p. 833.

CHAP. 560.—An Act To authorize the construction of a bridge across the Missouri River between the city of Chamberlain, in Brule County, and Lyman County, in the State of South Dakota.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Missouri River Bridge Company, a corporation duly organized and existing under the laws of the State of South Dakota, be, and is hereby, authorized to construct and maintain a bridge and approaches thereto across the Missouri River between the city of Chamberlain, in Brule

Missouri River, S. Dak.
Missouri Bridge Company may bridge, at Chamberlain.

County, in the State of South Dakota, and Lyman County, in the State of South Dakota. Said bridge shall be constructed to provide for the passage of wagons and vehicles of all kinds, animals, and foot passengers for such reasonable rates of toll and under such reasonable rules and regulations as may be prescribed by said corporation and approved by the Secretary of War. Wagon and foot bridge. Toll.

SEC. 2. That any bridge built under this Act and subject to its limitations shall be a lawful structure and shall be recognized and known as a post route upon which no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highway leading to said bridge. The United States shall also have the right to construct, without charge therefor, telegraph and telephone lines across and upon said bridge, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies. Lawful structure and post route. Telegraph, etc., rights.

SEC. 3. That said bridge shall be constructed as a pontoon bridge, and shall contain a drawspan giving a clear opening of not less than three hundred feet in length, which drawspan shall be maintained over the main channel of the river at an accessible and navigable point, and said bridge other than the drawspan shall be at right angles to the current of the river at high water: *Provided*, That the said draw shall be opened promptly by said company upon the reasonable signal for the passage of boats and rafts, and said company or corporation shall maintain at its own expense from sunset to sunrise such lights or other signals on said bridge as the Light-House Board shall prescribe. No bridge shall be erected or maintained under the authority of this Act which shall at any time unreasonably obstruct the free navigation of said river; and if any bridge erected under such authority shall, in the opinion of the Secretary of War, unreasonably obstruct such navigation, he is hereby authorized to cause the entire removal thereof or such change or alteration of such bridge to be made as will effectually obviate such obstruction, and all such alterations shall be made and all such obstructions shall be removed at the expense of the owner or owners of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river, caused or alleged to be caused by said bridge, the case may be brought in the district court of the United States of the State of South Dakota in whose jurisdiction any portion of said obstruction or bridge may be located: *Provided further*, That nothing in this act shall be so construed as to repeal or modify any of the provisions of the law now existing in reference to the protection of the navigation of rivers or to exempt this bridge from the operations of the same. Pontoon bridge. *Provisos.* Opening draw. Lights, etc. Unobstructed navigation. Changes. Litigation. Existing laws not affected.

SEC. 4. That no bridge shall be commenced or built under this Act until the location thereof and the plans for Secretary of War to approve plans, etc.

its construction, with such maps as shall be necessary for a full understanding of the regimen of the river for a distance of one mile above and one-half mile below the proposed site of said bridge, shall have been submitted to and approved by the Secretary of War, and any subsequent change in the plans, construction, or location of said bridge shall be subject to like approval.

Time of construction.

SEC. 5. That this Act shall be null and void unless the bridge herein authorized be commenced within one year and completed within three years from the date hereof.

Amendment.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, February 18, 1903.

February 18, 1903.

Vol. 32, p. 834.

CHAP. 561.—An Act Authorizing the Memphis, Helena and Louisiana Railway Company to construct and maintain a bridge across Saint Francis River, in the State of Arkansas.

Saint Francis River, Ark.

Memphis, Helena and Louisiana Railway Company may bridge.

Location.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Memphis, Helena and Louisiana Railway Company, a corporation created and existing under and by virtue of the laws of the State of Arkansas, be, and it is hereby, authorized to construct and maintain a bridge across the Saint Francis River, in the State of Arkansas, at such point in section twenty-five, township three north, range four east, in Lee County, in said State, suitable to the interests of navigation, as may hereafter be selected by said railway company for crossing said river with its railway line. Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of said railway company, may be used for the passage of wagons and vehicles of all kinds, for the transit of animals, and for foot passengers, for such reasonable rates of toll as may be fixed by said railway company and approved by the Secretary of War.

Railway, wagon, and foot bridge.

Toll.

Lawful structure and post route.

SEC. 2. That said bridge built under this Act and subject to its limitations shall be a lawful structure and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transmission over the same of the mails, the troops, and munitions of war of the United States than the rate per mile paid for the transportation over the railroad or public highways leading to the said bridge, and shall enjoy the rights and privileges of other post roads in the United States; and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal-telegraph purposes: *Provided*, That the bridge herein authorized to be constructed shall be so kept and managed by the company owning or operating it as to afford proper ways and means for the passage through or under it of vessels, barges, or rafts at all times, both by

Telegraph, etc., rights.

Proviso.
Unobstructed navigation.

day and by night; and there shall be displayed on said bridge, from sunset to sunrise, such lights and signals as the Light-House Board shall prescribe. Lights, etc.

SEC. 3. That if said bridge, erected and maintained under the authority of this Act, shall at any time substantially or materially obstruct the free navigation of said river, or shall, in the opinion of the Secretary of War, obstruct such navigation, he is hereby authorized to cause such change or alteration of said bridge to be made as will effectually obviate such obstruction, and such alteration shall be made and all such obstructions be removed at the expense of the owner or owners of said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the free navigation of said river the case may be brought in the district court of the United States in the State of Arkansas for the district in which any portion of said obstruction or bridge may be located: *Provided*, That nothing in this Act shall be so construed as to repeal or modify any of the provisions of law now existing in reference to the protection of the navigation of rivers, or to exempt said bridge from the operation of the same. Changes. Litigation. *Proviso.* Existing laws not affected.

SEC. 4. That all railroad companies desiring the use of the bridge constructed under this Act shall have and be entitled to equal rights and privileges relative to the passage of railway trains or cars over the same and over the approaches thereto upon payment of a reasonable compensation for such use; and in case the parties interested shall fail to agree upon the sum or sums to be paid and upon the rules and conditions to which each shall conform in using said bridge, all matters of issue between them shall, upon the application of either party, be determined by the district court of the United States in and for any district in which any portion of said bridge may be. Use by other companies. Compensation.

SEC. 5. That the bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe, and to secure that object the said company or corporation shall submit to the Secretary of War for his examination and approval a design and drawings of said bridge and a map of the location giving for the space of one mile above and one mile below the proposed location of the bridge the topography of the banks of the river, with shore lines at high and low water, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject, and until the said plans and location of the bridge are approved by the Secretary of War the bridge shall not be built; and should any change be made in the plans of the said bridge during the process of construction or after completion, such change shall be subject to the approval of the Secretary of War, and said structure shall be changed at the cost and expense of the owners thereof from time to time, as the Secretary of War may direct, so as to preserve the free and convenient navigation of said river. Secretary of War to approve plans, etc.

Time of construction.

SEC. 6. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date hereof.

Amendment.

SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, February 18, 1903.

February 18, 1903.

Vol. 32, p. 836.

CHAP. 562.—An Act To authorize the board of commissioners for the Connecticut bridge and highway district to construct a bridge across the Connecticut River at Hartford, in the State of Connecticut.

Connecticut River.

Bridge at Hartford, Conn., authorized.

Drawbridge.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the board of commissioners for the Connecticut bridge and highway district, a body politic and corporate, created by the laws of the State of Connecticut, be, and hereby is, authorized to construct and maintain a drawbridge across the Connecticut River at Hartford, in the State of Connecticut, between the city of Hartford and the town of East Hartford.

Secretary of War to approve plans, etc.

SEC. 2. That said bridge shall be built and located under and subject to such regulations for the security of navigation as the Secretary of War may prescribe; and to secure that object the said board of commissioners shall submit for his examination and approval designs and drawings of the bridge, and maps of the location, giving, for the space of one-half mile above and one-half mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents, and the soundings, accurately showing the bed of the river, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plans and locations are approved by him the bridge shall not be commenced or built; and should any change be made in said bridge before or after completion, such change shall be likewise subjected to the approval of the Secretary of War.

Unobstructed navigation.

Lights, etc.

Changes.

SEC. 3. That said bridge shall be kept and managed so as to offer reasonable and proper means for the passage of vessels through or under the same, and for the safety of vessels passing at night there shall be displayed on said bridge from sunset to sunrise such lights or other signals as the Light-House Board shall prescribe. And any changes in said bridge which the Secretary of War may at any time deem necessary to be made and shall order in the interest of navigation shall be made by said board of commissioners at their own expense.

Lawful structure and post route.

SEC. 4. That the bridge constructed, maintained, and operated under this Act and according to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which no higher charge shall be made for the transportation over the same of the mails, troops, and munitions of war of the United States than

the rate per mile paid for transportation of said mails, troops, and munitions of war over public highways leading to said bridge; and the United States shall have the right of way for telegraph, postal, and telephone purposes over said bridge, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies.

Telegraph, etc., rights.

SEC. 5. That this Act shall be null and void if actual construction of the said bridge be not commenced in two years and completed in six years from the date hereof.

Time of construction.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendment.

Approved, February 18, 1903.

CHAP. 563.—An Act To authorize the Pittsburg, Carnegie and Western Railroad Company to construct, maintain, and operate a bridge across the Allegheny River.

February 18, 1903.

Vol. 32, p. 837.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Pittsburg, Carnegie and Western Railroad Company, a corporation existing under the laws of the State of Pennsylvania, its successors and assigns, be, and the same are hereby, authorized to construct, maintain, and operate a railroad bridge across the Allegheny River from a point about seventy-five feet east of the southeast corner of Fourth street and Duquesne way, in the city of Pittsburg, in the State of Pennsylvania, to a point on the opposite bank of said river, at right angles with the current thereof, in the county of Allegheny in said State, the exact location, length of span, and height of said bridge to be determined and approved by the Secretary of War and Chief of Engineers. The said bridge, when built in accordance with the provisions and requirements of this Act, shall be a legal and lawful structure, and may be used as a highway for railway purposes.

Allegheny River, Pa. Pittsburg, Carnegie and Western Railroad Company may bridge, at Pittsburg.

SEC. 2. That the bridge authorized to be constructed under this Act shall be located and built under and subject to such regulations for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said company shall submit to the said Secretary of War, for his examination and approval, a design and drawing of the bridge and piers, and a map of the location, giving for the space of one mile above and one mile below the proposed location the topography of the banks of the river and the shore lines at high and low water, and giving for the space of one-half mile above and one-half mile below the proposed location an accurate representation of the bottom of the river, determined by actual soundings, and the location of any other bridge or bridges, and such other information as may be required for the full and satisfactory understanding of the subject by the Secretary of War; and the construction of said

Secretary of War to approve plans, etc.

bridge shall not be commenced until said location and plans have been submitted to and approved by the Chief of Engineers and the Secretary of War; and said plans, after having been approved by the Chief of Engineers and the Secretary of War, shall not be deviated from either before or after completion of the structure unless the modification of said plans be previously submitted to and receive the approval of the Chief of Engineers and the Secretary of War; and the said company shall, at its own expense, make from time to time such changes in said bridge as the Secretary of War may order in the interests of navigation.

Changes.

Lawful structure and post route.

SEC. 3. That any bridge constructed under this Act shall be a lawful structure and shall be known as a post-road, upon which no higher charge shall be made for the transportation over the same of the mails, the troops, and munitions of war of the United States than the rate per mile paid for the transportation over railroads or public highways leading to said bridge; and said bridge shall enjoy the rights and privileges of other post-roads in the United States, and the United States shall also have the right to construct a postal telegraph over said bridge without charge therefor.

Unobstructed navigation.

SEC. 4. That said bridge herein authorized to be constructed shall be so kept and maintained as at all times to afford proper means and ways for the passage of vessels, barges, or rafts, both by day and by night; and there shall be displayed on said bridge by the owners thereof from sunset to sunrise such lights or other signals as the Light-House Board may prescribe.

Toll.

SEC. 5. That said bridge may be constructed to provide for the passage of railway trains and street cars for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Use by other roads.

SEC. 6. That all railway companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of cars over the same and the approaches thereto upon the payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and several companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid and upon the rules and conditions to which each shall conform in using said bridge all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies.

Compensation.

Telegraph, etc., rights.

Time of construction.

SEC. 7. That the privileges hereby conferred and this Act shall become null and void if the construction of the bridge herein authorized be not commenced within two years and completed within four years after the passage of this Act.

Amendment.

SEC. 8. That Congress hereby reserves the right to alter, amend, or repeal this Act.

Approved, February 18, 1903.

CHAP. 565.—An Act To extend the time granted to the Muscle Shoals Power Company by an Act approved March third, eighteen hundred and ninety-nine, within which to commence and complete the work authorized in the said Act to be done by said company, and for other purposes.

February 18, 1903.
Vol. 32, p. 839.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the time allowed the Muscle Shoals Power Company by section two of an Act entitled "An Act granting to the Muscle Shoals Power Company right to erect and construct canal and power stations at Muscle Shoals, Alabama," approved March third, eighteen hundred and ninety-nine, to commence and complete the work therein authorized to be done be extended so that unless the work authorized in said Act to be done be commenced within two years and completed within four years from the date of this Act the privileges granted to said company by said first-mentioned Act shall cease and be determined; and the Secretary of War is authorized, in his discretion, to permit the said company to erect and construct dams which may abut on lands of the United States along the line of the Muscle Shoals Canal upon such terms and conditions as may be deemed just and equitable to the public interests.

Muscle Shoals, Ala.
Time extended for construction of canal, etc., by Muscle Shoals Power Company.
Vol. 30, p. 1351.

Construction of dams.

Approved, February 18, 1903.

CHAP. 566.—An Act To authorize the construction of a bridge across Bogue Chitto, in the State of Louisiana.

February 18, 1903.
Vol. 32, p. 839.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That authority is hereby granted, and consent is hereby given, for the building of a wagon and foot bridge across Bogue Chitto River, in the parish of Saint Tammany, State of Louisiana, by the police jury of said parish: *Provided*, That the plans and location for such bridge shall first be approved by the Secretary of War.

Bogue Chitto, La.
Saint Tammany Parish may bridge.

Proviso.
Secretary of War to approve plans, etc.

SEC. 2. That said bridge shall be a lawful structure, and shall be recognized and known as a post route, and shall enjoy the rights and privileges of other post roads in the United States; and no charge shall be made for the transmission over the same of the mails, troops, and munitions of war of the United States. Equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal-telegraph purposes, and any changes in said bridge which the Secretary of War may hereafter require and order, in the interest of navigation, shall be promptly made by the said police jury without expense to the United States.

Lawful structure and post route.

Telegraph, etc., rights.

Changes.

SEC. 3. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of approval hereof.

Time of construction.

Amendment.

SEC. 4. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, February 18, 1903.

February 18, 1903

Vol. 32, p. 839.

CHAP. 567.—An Act To authorize the construction of a bridge across the Monongahela River, in the State of Pennsylvania, by the Eastern Railroad Company.

Monongahela River, Pa. Eastern Railroad may bridge.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Eastern Railroad Company, a corporation created and organized under the laws of the State of Pennsylvania, its successors and assigns, be, and it is hereby, authorized to construct and maintain a bridge and approaches thereto over the Monongahela River, in the State of Pennsylvania, from a point on the north shore between Hazlewood avenue and the Glenwood highway bridge to a point on the south shore in the township of Baldwin or the township of Lower Saint Clair, in the county of Allegheny and State of Pennsylvania: *Provided*, That such location is suitable to the interests of navigation.

Location.

Proviso. Unobstructed navigation.

Lawful structure and post route.

SEC. 2. That said bridge shall be constructed for the passage of railway trains, and shall be a lawful structure, and shall be recognized and known as a post route, upon which no higher charge shall be made for the transmission over the same of the mails, the troops, and munitions of war of the United States than the rate per mile paid for the transportation over the railroads leading to the said bridge, and shall enjoy the rights and privileges of other post-roads in the United States, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal telegraph and telephone purposes: *Provided*, That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges in the passage of railroad trains over the same and the approaches thereto, upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies or any one of them desiring such use shall fail to agree upon the sum or sums to be paid and upon the rules and conditions to which each shall conform in the use of said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

Telegraph, etc., rights.

Proviso. Use by other roads

Compensation.

Secretary of War to approve plans, etc.

SEC. 3. That said bridge shall be built and located under and subject to such regulations for the security of navigation of such river as the Secretary of War shall prescribe; and to secure that object the company building the said bridge shall submit to the Secretary of War, for his examination and approval, a design and drawing of the bridge and a map of the location thereof, and until the said plan and location are approved by the Secretary of War the said bridge shall not be commenced or built,

and no changes shall be made in said bridge during the progress of construction, or after completion, unless approved by the Secretary of War; and the said company shall, at its own expense, make from time to time such changes in said bridge as the Secretary of War may order in the interests of navigation; and the said company, its successors and assigns, shall cause to be displayed on said bridge between the hours of sunset and sunrise, and at other times, such lights and other signals as may be prescribed by the Light-House Board.

Changes.

Lights, etc.

SEC. 4. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within two years from the date of the approval of this Act.

Time of construction.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendment.

Approved, February 18, 1903.

CHAP. 747.—An Act To authorize Washington and Westmoreland counties in the State of Pennsylvania to construct and maintain a bridge across the Monongahela River, in the State of Pennsylvania.

February 21, 1903

Vol. 32, p. 850.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That Washington County and Westmoreland County, Pennsylvania, be, and they are, jointly, authorized, pursuant to the laws of said State, to construct, maintain, and operate a county bridge across the Monongahela River between points in Carroll Township, Washington County, at or near the borough of Donora, as it would seem best, to a point in Rostraver Township, Westmoreland County, at or near the village of Webster. The said bridge, when built in accordance with the requirements of this Act, shall be a legal structure, and may be used for either or both railroad purposes or as a highway for the passage of persons, vehicles, and passenger cars.

Monongahela River.
Washington and Westmoreland counties, Pa., may bridge.

Location.

SEC. 2. That the bridge authorized to be constructed under this Act shall be located and built under and subject to such requirements for the security of navigation of said river as the Secretary of War shall prescribe; and to secure that object the said Washington and Westmoreland counties shall submit to the Secretary of War, for his examination and approval, a design and drawing for the bridge and a map of the location, giving for a space of one mile the depth and current of the river at all points, and the location of any other bridge or bridges, together with all other information touching said bridge and river as may be requisite for the Secretary of War to determine whether said bridge, when built, will conform to the provisions of this Act and cause no serious obstruction to the navigation of the river or injuriously affect the flow of water.

Secretary of War to approve plans, etc.

SEC. 3. That the Secretary of War is hereby authorized and directed, upon receiving said plan and map, and upon being satisfied that a bridge built upon said plan and at

Protection to navigation.

said location will conform to the provisions of this Act and cause no serious obstruction to the navigation of the river or injuriously affect the flow of water, to notify the said Washington and Westmoreland counties that he approves the same, and upon receiving said notification the said counties may proceed to the erection of the said bridge, conforming strictly to the approved plan and location; and until the Secretary of War shall approve the plan and location of the said bridge and notify the said counties, in writing, a bridge shall not be built or commenced; and should any change be made in the plan of the bridge during the progress of the work thereon, or after completion, such change shall be subject likewise to the approval of the Secretary of War. And any changes in said bridge which the Secretary of War may at any time deem necessary, and order in the interests of navigation, shall be made by the owners thereof at their own expense.

Changes.

Railroad, wagon, and foot bridge.

SEC. 4. That said bridge, at the option of the said Washington and Westmoreland counties, may be so constructed that the same can be used for the passage of wagons and vehicles of all kinds, and passenger cars, and for the transit of animals and foot passengers over the same, and also, in addition to these purposes, may be used for railroad purposes; and the counties maintaining the same shall have the right to charge such reasonable rates for toll as bridge companies are authorized to collect under the laws of the State of Pennsylvania: *Provided*, That if said bridge shall be constructed for railroad purposes, all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railroad trains or cars over the same upon the payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any one of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon the rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

Proviso.
Use by other roads.

Compensation.

Post road.

SEC. 5. That any bridge constructed under this Act shall be known as a post road, over which no higher charge shall be made for the transportation of mail, troops, and munitions of war, or other property of the United States, than the rate per mile charged for their transportation over the public highways leading to said bridge. The United States shall also have the right of way over said bridge for postal-telegraph purposes, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies.

Telegraph, etc., rights.

Unobstructed navigation.

Lights, etc.

SEC. 6. That the said bridge shall be so kept and managed at all times as not to interfere with the passage of vessels, barges, or rafts, both by day and by night; and there shall be displayed on said bridge by the owners thereof, from sunset to sunrise, such lights or other signals as the Light-House Board may prescribe.

SEC. 7. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced in one year and completed within three years from the date hereof. Time of construction.

SEC. 8. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment.

Approved, February 21, 1903.

CHAP. 748.—An Act Authorizing the commissioners' court of Escambia County, Alabama, to construct a bridge across Conecuh River at or near a point known as McGowans Ferry, in said county and State.

February 21, 1903.

Vol. 32, p. 852.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the commissioners' court of Escambia County, in the State of Alabama, be, and are hereby, authorized to construct, maintain, and operate a bridge across Conecuh River, said bridge to be located at a point suitable to the interests of navigation at or near a point known as McGowans Ferry, in said county and State.

Conecuh River, Ala. Escambia County may bridge, at McGowans Ferry.

SEC. 2. That said bridge shall be built and located under and subject to such regulations for the security of navigation as the Secretary of War may prescribe; and to secure that object the said commissioners' court of Escambia County shall submit for his examination designs and drawings of the bridge, and maps of the location, giving, for the space of one-half mile above and one-half mile below the proposed location, the topography of the banks of the river, the shore lines at high and low water, the direction and strength of the currents, and the soundings, accurately showing the bed of the river, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until the said plans and locations are approved by him the bridge shall not be commenced or built; and should any change be made in said bridge before or after completion, such change shall be likewise subject to the approval of the Secretary of War.

Secretary of War to approve plans, etc.

SEC. 3. That said bridge shall be kept and managed so as to offer reasonable and proper means for the passage of vessels through or under the same; and for the safety of vessels passing at night there shall be displayed on said bridge by the owners thereof, at their own expense, such lights or other signals as the Light-House Board may prescribe. And any changes in said bridge which the Secretary of War may at any time order in the interest of navigation shall be made by the owners thereof at their own expense.

Protection to navigation.

Changes.

SEC. 4. That the bridge constructed, maintained, and operated under this Act, and according to its limitations, shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transportation over the same of the

Lawful structure and post route.

mails, troops, and munitions of war of the United States than the rate per mile paid for transportation of said mails, troops, and munitions of war over public highways leading to said bridge; and the United States shall have the right of way for telegraph, postal, telephone, and other purposes over said bridge.

Telegraph, etc., rights.

Time of construction.

SEC. 5. That this Act shall be null and void if actual construction of the said bridge be not commenced in one year and completed in three years from the date hereof.

Amendment.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, February 21, 1903.

February 25, 1903.

Vol. 32, p. 854.

CHAP. 755.—An Act Making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and four, and for other purposes.

Legislative, executive, and judicial expenses appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, in full compensation for the service of the fiscal year ending June thirtieth, nineteen hundred and four, for the objects hereinafter expressed, namely:

* * * * *

Library of Congress.

LIBRARY OF CONGRESS.

* * * * *

Transfer of books from departments, etc.

The head of any Executive department or bureau or any commission of the Government is hereby authorized from time to time to turn over to the Librarian of Congress, for the use of the Library of Congress, any books, maps, or other material in the library of the department, bureau, or commission no longer needed for its use, and in the judgment of the Librarian of Congress appropriate to the uses of the Library of Congress.

Transfer of books to Free Public Library, D. C.

Any books of a miscellaneous character no longer required for the use of such department, bureau, or commission, and not deemed an advisable addition to the Library of Congress, shall, if appropriate to the uses of the Free Public Library of the District of Columbia, be turned over to that library for general use as a part thereof.

* * * * *

War Department.

WAR DEPARTMENT.

* * * * *

Engineer Office.

OFFICE OF THE CHIEF OF ENGINEERS: For chief clerk, two thousand dollars; five clerks of class four; four clerks of class three; four clerks of class two; four clerks of class one; one clerk, one thousand dollars; one assistant messenger, and two laborers; in all, thirty thousand eight hundred and forty dollars.

And the services of skilled draftsmen, civil engineers, and such other services as the Secretary of War may deem necessary, may be employed in the office of the Chief of Engineers, to carry into effect the various appropriations for rivers and harbors, fortifications, and surveys to be paid from such appropriations: *Provided*, That the expenditures on this account for the fiscal year ending June thirtieth, nineteen hundred and four, shall not exceed eighty thousand dollars; and that the Secretary of War shall each year, in the annual estimates, report to Congress the number of persons so employed and the amount paid to each. Draftsmen, etc. *Proviso.* Limit, etc.

* * * * *

PUBLIC BUILDINGS AND GROUNDS.

Public buildings and grounds.

OFFICE OF PUBLIC BUILDINGS AND GROUNDS: For one assistant engineer, one thousand eight hundred dollars; one clerk of class four, one clerk of class three, one messenger; landscape gardener, two thousand dollars; surveyor and draftsman, one thousand five hundred dollars; in all, nine thousand five hundred and forty dollars. Clerks, messengers, etc.

For overseers, draftsmen, copyists, foremen, gardeners, mechanics, and laborers employed in the public grounds, thirty-five thousand dollars. Overseers, etc.

For one sergeant of park watchmen, nine hundred and fifty dollars. Watchmen.

For day watchmen as follows: One in Franklin Park; one in Lafayette Park; two in Smithsonian grounds; one in Judiciary Park; one in Lincoln Park and adjacent reservations; one at Iowa Circle; one at Thomas Circle and neighboring reservations; one at Washington Circle and neighboring reservations; one at Dupont Circle and neighboring reservations; one at McPherson and Farragut parks; one at Stanton Park and neighboring reservations; two at Henry and Seaton parks; one at Mount Vernon Park and adjacent reservations; one for the greenhouses and nursery; two at grounds south of Executive Mansion; one at Garfield Park; one at Monument Park; one at Monument Park Annex (Potomac Park); twenty-one in all, at seven hundred and twenty dollars each, fifteen thousand one hundred and twenty dollars.

For night watchmen as follows: Two in Smithsonian grounds; one in Judiciary Park; two in Henry and Seaton parks; one in grounds south of Executive Mansion; one in Monument Park; one at Monument Park Annex (Potomac Park); two in Garfield Park; ten in all, at seven hundred and twenty dollars each, seven thousand two hundred dollars.

For watchman for the care of the monument and dock at Wakefield, Virginia, the birthplace of Washington, three hundred dollars. Wakefield, Va.

For contingent and incidental expenses, including purchase of professional and scientific books and periodicals, books of reference, blank books, photographs, and maps, seven hundred dollars. Contingent expenses.

Payment from District revenues.

Of the foregoing amounts appropriated under Public Buildings and Grounds the sum of twenty-nine thousand one hundred and thirty-five dollars shall be paid out of the revenues of the District of Columbia.

* * * * *

Rates of pay assistant messengers, firemen, etc.

SEC. 2. That the pay of assistant messengers, firemen, watchmen, laborers, and charwomen provided for in this Act, unless otherwise specially stated, shall be as follows: For assistant messengers, firemen, and watchmen, at the rate of seven hundred and twenty dollars per annum each; for laborers, at the rate of six hundred and sixty dollars per annum each, and for charwomen, at the rate of two hundred and forty dollars per annum each.

No payments to permanently incapacitated persons.

SEC. 3. That the appropriations herein made for the officers, clerks, and persons employed in the public service shall not be available for the compensation of any persons permanently incapacitated for performing such service.

Repeal.

SEC. 4. That all laws or parts of laws inconsistent with this Act are repealed.

Approved, February 25, 1903.

February 27, 1903.

Vol. 32, p. 908.

CHAP. 854.—An Act To provide for the erection at Washington, District of Columbia, of statues to the memory of Brigadier-General Count Pulaski and Major-General Baron von Steuben, of the Continental Army.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be erected in the City of Washington, District of Columbia, a statue of Brigadier-General Count Casimir Pulaski, of Poland, who came to America and, after declaring his intention to become a citizen of the Republic, offered his sword to Washington, under whose leadership in the great struggle for American Independence he lost his life at the siege of Savannah, Georgia, October eleventh, seventeen hundred and seventy-nine; and for the purpose of procuring and erecting said statue with a suitable pedestal, and for the preparation of a site, the sum of fifty thousand dollars, or so much thereof as may be necessary, is hereby appropriated out of any money in the Treasury not otherwise appropriated, the same to be expended under the direction of a commission to be composed of the Secretary of War, the chairman of the Committee on the Library of the Senate, the chairman of the Committee on the Library of the House of Representatives of the Fifty-seventh Congress, and the president of the Pulaski monument Polish central committee.

District of Columbia.

Erection of a monument to Count Pulaski authorized.

Appropriation.

Commission.

Erection of a monument to Baron Steuben.

SEC. 2. That there shall be erected in the city of Washington, District of Columbia, a statue of Frederick William Augustus Henry Ferdinand, Baron von Steuben, major-general and inspector-general in the Continental Army; and for the purpose of procuring and erecting said statue with a suitable pedestal, and for the preparation of a site, the sum of fifty thousand dollars, or so much

Appropriation.

thereof as may be necessary, is hereby appropriated out of any money in the Treasury not otherwise appropriated, the same to be expended under the direction of a commission to be composed of the Secretary of War, the chairman of the Committee on the Library of the Senate, and the chairman of the Committee on the Library of the House of Representatives of the Fifty-seventh Congress. Commission.

SEC. 3. That the commissions herein created are empowered, respectively, to select sites for the statues authorized by this Act on ground belonging to the Government: *Provided*, That said statues shall not be located in the grounds of the Capitol or Library of Congress. Sites. *Proviso.* Restriction.

Approved, February 27, 1903.

CHAP. 856.—An Act To provide for a union railroad station in the District of Columbia, and for other purposes. February 28, 1903.

Vol. 32, p 909.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Philadelphia, Baltimore and Washington Railroad Company, (a corporation duly created by consolidation and merger of the Philadelphia, Wilmington and Baltimore Railroad Company and the Baltimore and Potomac Railroad Company, their respective capital stocks, railroads, properties and franchises) or the terminal company provided for in section ten of the Act of Congress approved February twelfth, nineteen hundred and one, entitled "An Act to provide for eliminating certain grade crossings of railroads in the District of Columbia, to require and authorize the construction of new terminals and tracks for the Baltimore and Ohio Railroad Company in the city of Washington, and for other purposes," be, and each of them is hereby, authorized and required to locate, construct, maintain, and operate a double-track railroad, commencing at a point on the railroad of said Philadelphia, Baltimore and Washington Railroad Company at or near the crossing of Second street southwest, at the elevation of said railroad provided for in the said Act of Congress relating to the Baltimore and Potomac Railroad Company approved February twelfth, nineteen hundred and one; thence curving toward the north, crossing over Virginia avenue with a clearance of fifteen feet above the present curb thereof, crossing over First street southwest and Delaware avenue southwest, at a point about forty feet north of the north house line of E street, with a clearance of not less than sixteen feet; thence curving to the northward, crossing over Canal street and South Capitol street with a clearance of not less than fourteen feet above the curbs thereof; thence passing under the intersection of D street with New Jersey avenue, C street southeast, and B street southeast at the intersection with First street; thence continuing under the west side of First street to near E street northeast; thence curving to the eastward, crossing under the proposed circle at Massachusetts avenue to

District of Columbia. Union railroad station.

Philadelphia, Baltimore and Washington Railroad, etc. New terminal and track privileges granted to.

Vol. 31, p. 775.

Location of tracks.

Vol. 31, p. 767.

a connection with the tracks in the proposed terminal station to be built on the north side of Massachusetts avenue hereinafter provided for; thence running from the said north line of Massachusetts avenue on the terminal station structure hereinafter mentioned northeastwardly to Delaware avenue; thence, still on said terminal structure, and on the easternmost part of the viaduct, hereinafter mentioned, to be located in Delaware avenue, to the north side of M street northeast; thence northwardly still on Delaware avenue, crossing Florida avenue overhead, by means of a girder bridge, or by masonry arches, to the north side of said avenue; thence by a line, still northwardly, curving to the east, and crossing under New York avenue, by the most practicable route, in a general northeasterly direction, to a point on the north line of Montana avenue, as projected, and shown on plan filed as required by this Act, from which terminal point the Philadelphia, Baltimore and Washington Railroad Company, its successors and assigns, shall be, and is hereby, authorized to locate, construct, maintain, and operate a line of railroad, of two or more tracks, by the most practicable route, to a point of connection with its present railroad near Magruder Station, in the State of Maryland, and to acquire, from time to time, such lands between Montana and Florida avenues, and east of the present Metropolitan Branch of the Baltimore and Ohio Railroad, as it may need for sidings, switches, yard tracks, with suitable structures and appliances, and other proper corporate purposes in connection therewith, and to use the same accordingly, subject to the approval of the Commissioners of the District of Columbia; and a right of way one hundred feet in width for said line of railroad as it shall be located through and upon lands belonging to the Reform School of the District of Columbia is hereby granted to and vested in said Philadelphia, Baltimore and Washington Railroad Company, its successors and assigns, on such terms as the Attorney-General shall prescribe:

Magruder station connection.

Proviso. Restrictions.

Provided, however, That the portion of said line of railroad lying south of Florida avenue within the limits of the city of Washington shall be used for passenger trains only, except in cases of temporary emergency, and then for a period not exceeding twenty-hour hours, unless with the consent of the Commissioners of the District of Columbia.

Joint construction.

JOINT CONSTRUCTION.

Division of cost.

It is the intention of this Act that the portion of the line of railroad above authorized lying between the north line of Massachusetts avenue and the north line of Florida avenue, if constructed by said Philadelphia, Baltimore and Washington Railroad Company, shall be constructed jointly with the said terminal company, and, with the viaduct and elevated terminal carrying the same above or over the streets and avenues of the city, be continuous with the elevated terminal and viaduct of said terminal com-

pany; and in that case the cost of said joint works shall be borne by said railroad company and said terminal company in such proportions as they may agree on, or, in case of a disagreement, as may be determined by the supreme court of the District of Columbia in such manner as that court shall prescribe. If, however, the Philadelphia, Baltimore and Washington Railroad Company shall deem it expedient or advisable, and shall so elect, that the whole or any portion of the railroad hereby authorized south of the point hereinbefore designated, on the north line of Montana avenue, should be constructed and owned by said terminal company, then and thereupon the said Philadelphia, Baltimore and Washington Railroad Company shall acquire, by purchase, from the said Baltimore and Ohio Railroad Company one-half of the whole then issued capital stock of the terminal company, and be entitled to subscribe for and acquire equally with said Baltimore and Ohio Railroad Company all thereafter issued stock of said terminal company; and, upon such election, said terminal company shall have as full power and authority to locate, construct, maintain, and operate said line of railroad as it is possessed of with reference to the other works, specified in this Act, to be constructed by it, or which it is authorized to construct under the said Act relating to the Baltimore and Ohio Railroad Company, approved February twelfth, nineteen hundred and one.

Construction by terminal company alone.

Vol. 31, p. 775.

UNION STATION.

SEC. 2. That the main passenger station and terminals for the accommodation of the passenger traffic of both the Baltimore and Ohio Railroad Company and the Philadelphia, Baltimore and Washington Railroad Company, and the passenger traffic of such other companies as may be moved over the railroads of either of said two companies, as provided in section eleven, shall be constructed by said terminal company within the area described as follows, namely:

Main passenger station, etc.

Beginning on the north side of Massachusetts avenue at a distance of three hundred feet northwest from the west side of Delaware avenue measured at right angles thereto; thence by a line parallel with Delaware avenue and three hundred feet therefrom northeastwardly to a point in the south line of I street northeast; thence by a straight line northeastwardly to a point in the intersection of the west line of Delaware avenue with the south line of L street northeast; thence eastwardly, along the south line of L street northeast, to a point in the intersection with the west line of Second street northeast; thence south, along the west line of Second street northeast, to a point about eighty feet north of the north line of H street northeast; thence by a line parallel with and distant three hundred feet measured at right angles thereto eastwardly from the east line of Delaware avenue,

Location.

southwestwardly to a point in the north line of Massachusetts avenue; thence by the said north line of Massachusetts avenue to the point of beginning.

Cost and character of station.

The terminal station contemplated by this Act shall cost not less than four million dollars and shall be monumental in character, and the plans thereof shall be subject to the approval of the Commissioners of the District of Columbia.

Acquiring lands.

And for the purposes of said passenger station and terminal said terminal company is fully authorized and empowered to acquire, take, and use all the lands and property lying within said area, or so much thereof as it may deem necessary: *Provided*, That on the westerly side of said railway station sufficient land for a street not less than forty feet in width shall be dedicated to the District of Columbia by the said railroad companies and said terminal company.

Proviso. Dedication of land for street.

Viaduct.

VIADUCT.

Location.

SEC. 3. That the viaduct leading northwardly from the passenger station and terminal between the south side of L street and the north side of M street may occupy so much of the bed of Delaware avenue as lies west of a line drawn parallel with the east building line of said avenue and forty feet westwardly therefrom: *Provided, however*, That said terminal station and viaduct shall be so constructed as to permit H, K, L, and M streets, and Florida avenue to be passed and continued under the same through openings or spaces of sufficient clearance to permit the use of said streets and avenues in the form and manner and of the dimensions shown and indicated on the plan and profiles agreed upon between the Baltimore and Ohio Railroad Company, the terminal company, and the Philadelphia, Baltimore and Washington Railroad Company and the Commissioners of the District of Columbia, and filed in the office of the Engineer Commissioner; and the said terminal company shall also grade and pave the said passageways at the time of their construction to the satisfaction of the Commissioners of the District of Columbia, but thereafter the maintenance of the pavements and roadways shall be provided for as in the case of other public highways in the District of Columbia.

Proviso. Passage for streets.

Grading and paving.

Width of viaduct.
Vol. 31, p. 774.

Said viaduct shall be of sufficient width to carry, in addition to the tracks authorized by said Act relating to the Baltimore and Ohio Railroad Company, approved February twelfth, nineteen hundred and one, such tracks as may be required to accommodate the traffic of the said Philadelphia, Baltimore and Washington Railroad Company, and one or more freight tracks for the Baltimore and Ohio Railroad Company, to be located on the west side thereof.

YARDS AND SWITCHES FOR TERMINAL COMPANY.

Yards, switches, etc.

Said terminal company is also expressly authorized and empowered, subject to the approval of the Commissioners of the District of Columbia, to acquire and become pos-

sessed of such lands in the District of Columbia, outside the city limits, as may be from time to time needed for the purpose, and thereon to construct, maintain, own, and operate yard tracks, switches, roundhouses, shops, and other structures to adequately accommodate the handling, shifting, housing, storing, cleaning, and repairing of the locomotives and cars of such companies as shall be entitled to use the said passenger station and terminal; and also to establish, maintain, and operate the necessary tracks connecting the same with the tracks on Delaware avenue: *Provided*, That said roundhouses and shops shall be located as designated on plans to be approved by the Commissioners of the District of Columbia, and filed in the office of the Engineer Commissioner.

Proviso. Location of roundhouses, etc.

BALTIMORE AND OHIO FREIGHT TRAFFIC.

Additional freight facilities for Baltimore and Ohio Railroad.

SEC. 4. That in order to provide terminal facilities for the freight traffic of the Baltimore and Ohio Railroad Company in lieu of those which said company is now authorized to have within the area to be occupied by the passenger station and terminal, described in the Act relating to it, approved February twelfth, nineteen hundred and one, the said Baltimore and Ohio Railroad Company be, and it is hereby, authorized and empowered (in addition to the power and authority conferred upon it by the provisions of said Act relating to it, approved February twelfth, nineteen hundred and one) to locate, construct, maintain, and operate tracks, switches, sheds, warehouses, other structures, and facilities necessary or proper for a freight-delivery yard and terminal in Eckington, in, over, and upon the bed of Quincy street and Third street between New York avenue and R street, and in and upon the property bounded by New York avenue, Florida avenue, Eckington place, and R street, outside the limits of the city of Washington; and also within the city of Washington in, over, and upon the bed of Second street between M and N streets and in and upon squares seven hundred and eleven, seven hundred and twelve, and seven hundred and thirteen; and also to extend its tracks and switches north of V street on the east side of the main tracks of its Metropolitan Branch Railroad to Rhode Island avenue extended; and said company is hereby authorized to acquire, by purchase or condemnation, as provided in this Act, the lands and property necessary for the additional freight facilities above mentioned.

Vol. 31, p. 774.

In Eckington.

In city limits.

STREETS TO BE VACATED.

Streets to be vacated.

SEC. 5. That to accomplish the purposes of this Act the following-named streets, in addition to the streets vacated, abandoned, and closed by the provisions of said Act relating to the Baltimore and Ohio Railroad Company, approved February twelfth, nineteen hundred and one, are hereby vacated, abandoned, and closed, to wit: In Eckington, T street shall be closed between the west line of Seventh

Vol. 31, p. 775.

In Eckington.

street and the right of way of the Metropolitan Branch of the Baltimore and Ohio Railway Company; Thomas street from the west line of Seventh street westward; Seaton street from Sixth street to Seventh street; S street from Sixth street to the Brentwood road; Brentwood road from the west side of Seventh street to the south side of S street; Third street from the south side of R street to Florida avenue; Quincy street shall be closed and abandoned: *Provided*, That no streets or avenues shall be closed or abandoned under the provisions of this Act or of the Acts relating to the Baltimore and Ohio Railroad Company and the Baltimore and Potomac Railroad Company, approved February twelfth, nineteen hundred and one, until all of the property abutting on the streets or avenues, or portions thereof, provided to be closed in said Acts, shall have been acquired by said railroad company or companies or the terminal company referred to herein, either by condemnation or purchase, as hereinafter provided. No streets or avenues, except Ninth, Twelfth, and Fifteenth streets and New York avenue, shall be opened across the railroads constructed under authority of this Act between Florida and Montana avenues; and said Ninth, Twelfth, and Fifteenth streets, when and as opened, shall be carried above the railroads by suitable viaduct bridges, the cost whereof, with their approaches within the limits of the right of way, shall be paid by the terminal company, but shall be maintained as in the case of other public highways in the District of Columbia: *Provided*, That the Baltimore and Ohio Railroad Company shall make adequate and suitable provision for carrying T street over the railroad right of way to the west line of Seventh street east in a manner satisfactory to the Commissioners. And the terminal company shall construct the necessary tunnels or viaducts to permit New York avenue to be carried with its full width between parking lines over their rights of way as herein authorized; and shall fill said avenue to a like width to the grade approved for said avenue for the purposes of this Act across said right of way and westward to Florida avenue, and shall support the sides of said avenue with embankments or retaining walls wherever it abuts upon property belonging to said railroad, and nothing contained in the provisions heretofore made for the vacating of Third street and Brentwood road across said avenue shall operate to close said avenue in any way as a public thoroughfare at its full established width: *And provided further*, That the Baltimore and Ohio Railroad Company shall dedicate to the District of Columbia the necessary land to widen Eckington place on its east side to its full width in accordance with the recorded plans for street extensions, and the Philadelphia, Baltimore and Washington Railroad Company shall dedicate to the District of Columbia the necessary land to form a western exit from Ivy street to Canal street as shown on the plan filed by said company as required by this Act. Also, in the city of Washington the following-named streets are hereby vacated, aban-

Provisos. Restrictions.

Streets to be elevated.

T street.

New York avenue.

Widening Eckington place.

Streets to be vacated in city.

doned, and closed, to wit: Ivy street between South Capitol street and a point two hundred and twenty feet east thereof; Second street northeast, between N street and Delaware avenue, and, between the north side of M street and the south side of L street, so much of the bed of Delaware avenue as lies west of a line drawn parallel with the east building line of said avenue and forty feet westerly therefrom; also all parts of streets included within the area of the terminal herein described, except H and K streets, it being the intention of this Act that all streets, avenues, ways, and alleys within the area to be occupied and used for said terminal and terminal tracks shall be completely vacated, abandoned, and closed, and the use thereof and of any public reservation or street spaces of the United States within said area be granted to the company constructing such terminals for the purposes of the same, except that H and K streets shall be carried under said terminal and terminal tracks substantially in accordance with the plans agreed upon between the Baltimore and Ohio Railroad Company, the terminal company, and the Philadelphia, Baltimore and Washington Railroad Company and the Commissioners of the District of Columbia, and filed in the office of the Engineer Commissioner.

MASSACHUSETTS AVENUE PLAZA.

Massachusetts avenue plaza.

Acquisition of land authorized.

The Commissioners of the District of Columbia are hereby authorized and directed to cause all streets, avenues, ways, and alleys to be closed as provided in this Act, and in accordance with the intent thereof; and also to lay out a circle or plaza at the intersection of Massachusetts avenue and Delaware avenue, and to lay out and open streets leading to such circle, and to change the lines of certain other adjacent streets and of Ivy street, as shown on a plan filed in the office of the said Commissioner, and also to make such changes in the lines and grades of any existing street, avenue, or way and in the recorded plans of street extensions as may be reasonably required, deemed necessary, or advisable in the construction of the works hereby authorized. And authority is hereby given said Commissioners to acquire by purchase, or to condemn in accordance with existing law, the land necessary to carry out the proceedings authorized by this Act, and to reconstruct, grade, and pave, by day labor or otherwise, the streets, avenues, and ways changed in line or grade or newly created hereunder.

Sale, etc., of abandoned land.

And authority is hereby given the District Commissioners to sell or equitably exchange any portion of existing public space abandoned by reason of the adjustment of streets as an approach to the plaza or circle at Massachusetts avenue: *Provided*, That the provisions of section three of the Act of February twelfth, nineteen hundred and one, in relation to new terminals for the Baltimore and Ohio Railroad Company which vacate, abandon, and close D and E streets between First street and North Capitol

Proviso.
Streets reopened.
Vol. 31, p. 775, amended.

street and Delaware avenue between C street and the south line of Massachusetts avenue be, and the same are hereby, repealed, and said streets are restored to the same status and ownership in all respects as they were prior to the passage of said Act.

DAMAGES.

Payment of damages by the District.

All damages to adjacent property owners resulting from, incidental to, or connected with changes in the grades of the streets or alleys authorized by this Act shall be borne, paid for, and defrayed by the District of Columbia, and shall be recoverable by action of law against the said District on the part of the owners of the property so damaged. Fifty per centum of the amounts so recovered shall be refunded to the said District by the United States: *Provided*, That in determining the damages as herein provided the jury shall take into consideration any benefits that may have accrued by reason of the elimination of grade crossings or of the location of said station in proximity to the property alleged to have been damaged.

United States to refund one-half.

Proviso. Benefits.

TAXATION.

Basis of taxation.

SEC. 6. That the property owned or occupied by the terminal company, or by the Philadelphia, Baltimore and Washington Railroad Company, or by the Baltimore and Ohio Railroad Company under authority of this Act, or otherwise, together with the improvements that may be put thereon, shall be subject to taxation in the District of Columbia in the same manner and to the same extent as other property in the District, and all tracks and sidings shall be taxed as real estate: *Provided*, That no assessment, valuation, or tax shall be made, laid, or levied on the stations, terminals, and lines of railroad located, constructed, or maintained under the authority of this Act in excess of that which would or could be lawfully made, laid, or levied if said stations, terminals, and lines of railroad were located, constructed, and maintained without the use of bridges, tunnels, viaducts, retaining walls, or other structures necessary or properly employed to elevate or to depress the same as required by this Act; it being the true intent and meaning hereof that the lines of railroad and terminals hereby authorized shall be assessed and valued for the purpose of taxation and taxed on the same basis as if the same were not constructed and maintained by means of such bridges, tunnels, viaducts, retaining walls, and other structures: *Provided*, That such portions of the terminal structure or viaduct as may be constructed and used for storage or like commercial purpose shall be subject to taxation in the same manner as other property in the District of Columbia.

Provisos. Cost of bridges, etc., exempt.

Structures for commercial use taxable.

PLANS.

Approval of plans by District Commissioners.

SEC. 7. That before any portion of the work of construction within the District of Columbia herein described shall be begun, plans thereof in accordance with the provisions

of this Act shall be prepared by the company undertaking such work, and shall be submitted for approval to the Commissioners of the District of Columbia; also in so far as public parks and reservations may be affected, for approval also of the Secretary of War; and also in so far as underground construction is involved, for approval also of the Superintendent of the Library of Congress. Duly authenticated copies of said plans shall, after approval, be filed with the Commissioners of the District of Columbia, and all work shall be done in accordance therewith. The company undertaking such work shall deposit with the collector of taxes such sums of money as the Commissioners of the District may reasonably require to cover the cost of District inspection.

Deposit for cost of inspection.

LIMIT OF TIME FOR COMPLETION.

Time of construction.

SEC. 8. That of the works herein described, the lines of railroad leading northward and southward from the main passenger station and terminal connecting the same with lines of the Baltimore and Ohio Railroad Company and lines of the Philadelphia, Baltimore and Washington Railroad Company, respectively, shall be completed, and the main passenger station and terminals shall be ready for occupancy, within five years from the date of the passage of this Act. The construction of said passenger station and terminal and viaduct by said terminal company, in accordance with the provisions of this Act, shall be deemed and taken to be a full compliance by the Baltimore and Ohio Railroad Company with the requirements in that regard of the said Act relating to it, approved February twelfth, nineteen hundred and one, and the respective periods of five and six years from the passage of said Act, as mentioned in section eight thereof, are hereby extended respectively for five and six years from the passage of this Act. Except as modified by this Act, all the provisions of said Act relating to the Baltimore and Ohio Railroad Company, approved February twelfth, nineteen hundred and one, shall be and remain in full force and effect.

Vol. 31, p. 778.

REMOVAL OF TRACKS FROM THE MALL.

Removal of tracks from the Mall.

The construction of the lines of railroad hereinbefore mentioned, connecting the railroad of said Philadelphia, Baltimore and Washington Railroad Company with said main passenger station and terminal, whether constructed wholly by said Philadelphia, Baltimore and Washington Railroad Company or said terminal company, or partly by each, shall relieve said Philadelphia, Baltimore and Washington Railroad Company of any and all duties and obligations respecting relocation of its present passenger tracks and terminal, and location, construction, and operation of new passenger station and new terminal tracks, as prescribed in the Act relating to the Baltimore and Potomac Railroad Company, approved February twelfth, nineteen hundred and one; and upon completion either by said Philadelphia, Baltimore and Washington Railroad

Vol. 31, p. 767.

Company or said terminal company, or in part by one and in part by the other, of said connecting lines of railroad ready for use, in connection with said main passenger station and terminal, as contemplated by this Act, and within five years from the passage of this Act the said Philadelphia, Baltimore and Washington Railroad Company shall be, and it is hereby, required to remove its present eastern connection between its passenger station and its line on Virginia avenue via Sixth street, including the tracks on Sixth street, and its western connection via Maryland avenue, and to convey its passenger station building to the United States. And in consideration thereof, and of the relinquishment and surrender by said Philadelphia, Baltimore and Washington Railroad Company of its right to occupy and use the portion of the Mall, and to maintain thereon a new passenger station and terminals, granted to the Baltimore and Potomac Railroad Company by the Act aforesaid in consideration of and as a contribution toward the large expenditures to be made by said company in the relocation and improvement of its line of railroad and elimination of grade crossings resulting therefrom, as required by said Act, the sum of one million five hundred thousand dollars shall be paid to said Philadelphia, Baltimore and Washington Railroad Company, its successors and assigns, out of any moneys in the Treasury of the United States not otherwise appropriated, and said sum of one million five hundred thousand dollars is hereby expressly appropriated for this purpose, and shall be paid upon presentation of a certificate by the Commissioners of the District of Columbia that said passenger station and terminal and connecting lines of railroad contemplated by this Act are ready for occupancy. Except as modified by this Act, all provisions of said Act relating to the Baltimore and Potomac Railroad Company, approved February twelfth, nineteen hundred and one, and all rights, powers, remedies, and processes thereby conferred on said last-named company, or upon Southern Railway Company, shall remain and continue in full force, and with like effect as if herein reenacted at length; and all rights, powers, and privileges granted to, or duties imposed upon, said Philadelphia, Baltimore and Washington Railroad Company by this Act shall accrue to and devolve upon its successors and assigns, as provived with respect to the Baltimore and Potomac Railroad Company by section fifteen of said Act relating to said Baltimore and Potomac Railroad Company, approved February twelfth, nineteen hundred and one, and all provisions of said section shall be applicable thereto in all respects, and in like manner as they are made applicable to the rights, privileges, and duties granted to or imposed upon said company by said last-mentioned Act.

Conveyance of old station to United States.

Surrender of railroad rights to the Mall.

Appropriation for payment to company.

Time of payment.

Prior rights, etc., continued. Vol. 31, p. 767.

Rights accrue to successors, etc.

CONDEMNATIONS.

Condemnation proceedings. Vol. 31, pp. 767, 774.

SEC. 9. That in the execution of the powers conferred by this Act, or by either of said before-mentioned Acts, approved February twelfth, nineteen hundred and one, by

the terminal company, the Philadelphia, Baltimore and Washington Railroad Company, or the Baltimore and Ohio Railroad Company, each of said companies may acquire, by purchase or condemnation, the lands and property necessary for all and every the purposes contemplated by each of said last-mentioned Acts and this Act respectively; and such condemnation shall be effected in the manner and by the methods and processes provided by sections six hundred and forty-eight to six hundred and sixty-three both inclusive, of the Revised Statutes relating to the District of Columbia, which said sections, despite any repeal thereof, are hereby continued in full force and effect, and, for the purposes contemplated by this section, are hereby specially enacted, with like effect as if the same were incorporated herein at length: *Provided*, That in every case wherein an assessment of damages or an award shall have been returned by the appraisers the company, upon paying into court the amount so assessed or awarded, may enter upon and take possession of the land and property covered thereby, irrespective of whether exceptions to said assessment or award shall be filed or not, and the subsequent proceeding shall not interfere with or affect such possession, but shall only affect the amount of compensation to be paid: *And provided further*, That any property owner whose land is included within such location shall have the right, within two years, to begin proceedings to compel the appropriation of said land by said company and the payment of damages in the same manner as if the proceedings had been instituted by the company under the provisions of this Act.

R. S., D. C., secs. 648-663, pp. 78, 79.

Provisos. Possession.

Proceedings to compel appropriation of lands.

The said terminal company, in respect of the additional works hereby authorized to be undertaken by it, shall be vested with and may exercise all the powers, authorities, rights, and privileges granted by the provisions of sections six hundred and eighteen to six hundred and seventy-six, both inclusive, of the Revised Statutes relating to the District of Columbia, to the same extent as if said provisions were fully set forth and enacted herein, and shall also be vested with and enjoy all the powers, authorities, rights, and franchises conferred or granted by said Act relating to the Baltimore and Ohio Railroad Company, approved February twelfth, nineteen hundred and one, except the power to sell all its railroad and works and property to the Baltimore and Ohio Railroad Company, as provided in said last-mentioned Act: *Provided, however*, That the Philadelphia, Baltimore and Washington Railroad Company shall have the right to acquire, own, and hold one-half of the capital stock of said terminal company, whether now or hereafter issued, and said Baltimore and Ohio Railroad Company shall make necessary transfers thereof accordingly.

Additional works.

R. S., D. C., secs. 618-676, pp. 74-81.

Vol. 31, p. 774.

Exception.

Proviso. Capital stock.

POWER TO CONTRACT.

The Baltimore and Ohio Railroad Company, the Philadelphia, Baltimore and Washington Railroad Company, and the said terminal company shall have power to con-

Traffic contracts.

tract each with the other, or with both the others, or with any other railroad company or companies whose passenger traffic may be moved over the railroads of either of said two railroad companies as provided in section eleven, in regard to the construction, maintenance, use, or operation of any line or lines of railroad, terminals, terminal tracks, stations, or other works or properties, held, owned, or possessed by any of said companies within the District of Columbia, or authorized so to be, or for the lease of the same upon such terms as may be agreed upon between the parties to any such contract. Said terminal company shall also have the right and power, exercisable at any time, to sell and convey, either to the Baltimore and Ohio Railroad Company or to the Philadelphia, Baltimore and Washington Railroad Company, so much of the line of railroad constructed by the said terminal company under the authority of this Act, north of the north line of Florida avenue, as may be set apart for the exclusive use of the traffic of either of said railroad companies by their mutual consent.

Sale by terminal company.

Magruder station line.

MAGRUDER STATION LINE.

Location, etc., of tracks.

SEC. 10. That in the location, construction, and maintenance of the connecting line of railroad which the Philadelphia, Baltimore and Washington Railroad Company is by this Act authorized and empowered to locate, construct, maintain, and operate, from the point hereinbefore mentioned on the north line of Montana avenue to a point of connection with its railroad near Magruder Station, in the State of Maryland, said Philadelphia, Baltimore and Washington Railroad Company shall have, be possessed of, and exercise the powers and processes of condemnation as prescribed by section nine of this Act, and also all authorities, rights, powers, privileges, and franchises conferred upon or vested in the Baltimore and Ohio Railroad Company by the twelfth section of said Act relating to it, approved February twelfth, nineteen hundred and one, in respect to the line of railroad therein authorized, and shall be subject to the same limitations and restrictions as in said twelfth section set forth.

Vol. 31, p. 780.

Intersecting highways.

INTERSECTING HIGHWAYS.

Any and all streets or highways within the District of Columbia now or hereafter planned or projected to cross any line of steam railroad in the District of Columbia, which may be hereafter opened to public use, shall be located, constructed, and maintained either beneath such railroad by a suitable subway, or above the same by a suitable viaduct bridge at such altitude as will not interfere with the free and safe operation thereof. The cost and expense of opening said streets or highways within the limits of such railroad company's right of way, including the cost of constructing the portion of any viaduct bridge, within said limits, shall be borne and paid half by

Subways, etc.

Cost of opening streets, etc.

such railroad company, its successors and assigns, and half by the District of Columbia and the United States, but after construction the cost of maintenance shall be wholly borne and paid as in the case of other public highways in the District of Columbia; and the portions of such streets now or hereafter planned or projected as above which lie within a right of way belonging to such railroad company shall be dedicated by such company as a public thoroughfare when the portions of such street adjoining such right of way have been similarly dedicated or otherwise acquired. Maintenance.

SEC. 11. That any railroad company now or hereafter lawfully existing and authorized to extend a line of railroad into the District of Columbia, or having secured the right to operate over the lines of any other then existing railroad, to a point of connection with the tracks of said terminal company, shall have the right to the joint use of said station and terminals upon the payment of a reasonable compensation for the use of the same; and if the parties be unable to agree upon such terms, then the same shall be prescribed by the supreme court of the District of Columbia, upon petition of either party in interest, under such rules of procedure as the said court shall prescribe. Use by other roads. Compensation.

SEC. 12. That the Philadelphia, Baltimore and Washington Railroad Company shall establish and maintain a substation with suitable accommodation for passenger travel at a convenient location north of the Long Bridge and at a point to be approved by the Commissioners of the District of Columbia. Substation at Long Bridge.

AMENDMENT AND REPEAL.

SEC. 13. That Congress reserves the right to alter, amend, or repeal this Act. Amendment.

Approved, February 28, 1903.

CHAP. 857.—An Act To authorize the construction of a bridge across the Missouri River and to establish it as a post road. February 28, 1903.

Vol. 32, p. 918.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for the Kansas City, Parkville and Saint Joseph Electric Railway Company (a corporation organized under the laws of the State of Missouri), its successors or assigns, to construct a bridge across the Missouri River at a point on the north boundary line of Kansas City, Missouri, to a point opposite the said Kansas City, Missouri, on the north side of said river, in Clay County, in the State of Missouri, said bridge to be so placed as to be erected between what is known as the Hannibal Bridge and Troost avenue, in Kansas City, Missouri; that said bridge may be constructed for railway and postal service Missouri River. Kansas City, Parkville and Saint Joseph Electric Railway Company may bridge, at Kansas City, Mo.

and a passage for persons and vehicles, with single or double tracks for railway traffic, and which shall be under the conditions and limitations hereinafter specified.

Unobstructed navigation. Litigation.

SEC. 2. That said bridge shall not unreasonably interfere with the free navigation of said river; and in case of any litigation arising therefrom such litigation may be tried and determined by any circuit court of the United States whose jurisdiction embraces either terminus of said bridge.

Construction.

SEC. 3. That the bridge herein authorized to be constructed may be constructed either as a drawbridge or as a high bridge with unbroken and continuous spans. If constructed of unbroken and continuous spans, then it shall not be of less elevation than fifty-two feet above the high-water grade line for bridges as established by the Missouri River Commission. Nor shall any of the spans of said bridge over the waterway be less than four hundred feet in the clear between the piers and abutments, and the piers thereof shall be parallel with the current of the river and the bridge itself at right angles thereto as nearly as may be. If said bridge is constructed as a drawbridge, the same shall be constructed as a pivot drawbridge, with a draw over the main channel, with spans of such clear width of opening as the Secretary of War shall prescribe, and the next adjoining spans to the draw shall also be of such length as he shall prescribe, and said spans shall not be less than ten feet above extreme high-water mark, measuring from the bottom chord of said bridge; and the piers of said bridge shall be parallel with the current of the river and the bridge itself at right angles thereto as nearly as may be: *Provided*, That the said corporation, its successors or assigns, shall build and maintain at all times, as accessory works to said bridge, such booms, piers, dikes, guard fences, and similar devices as may be necessary, in the judgment of the Secretary of War, to insure at all times a permanent channel for a sufficient distance above and below the bridge site, and for the guiding of rafts, steamboats, and other water craft safely through or under said bridge: *And provided further*, That said draw shall be opened promptly upon proper signal for the passage of boats.

High bridge. Drawbridge. *Provisos.* Aids to navigation. Opening draw.

Lawful structure and post route.

SEC. 4. That any bridge constructed under this Act shall be a lawful structure and shall be known as a post road, and the same is hereby declared to be a post road, over which no higher charge shall be made for the transmission of mails, troops, and munitions of war of the Government of the United States than the rate per mile charged for their transportation over the railroad or public highways leading to the said bridge, and equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies. The United States shall have also the right of way over said bridge for postal-telegraph and telephone purposes.

Telegraph, etc., rights.

Street railway, wagon, and foot bridge.

SEC. 5. That said bridge shall be constructed to provide for the passage of wagons and vehicles or all kinds of street

railway cars and motors, as well as foot passengers, and for all road travel, and all street railways desiring to use said bridge shall be entitled to equal rights and privileges in using the same and the machinery and fixtures thereto belonging, and also the approaches thereto, at reasonable compensation and rate of toll, as may be approved from time to time by the Secretary of War, and in case of any disagreement between the owner or owners of said bridge and those desiring its use, in respect to tolls to be paid and the rules and conditions to be complied with in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties.

Use by other roads.

Toll.

SEC. 6. That the said railway company before entering upon the construction of such bridge shall submit to the Secretary of War plans thereof, and a map of the location giving, for one mile above and one mile below said location, the topography of the banks of the river, the shore lines at high and low stages of water, showing also the bed of the river and the channel, with such other and further information as the Secretary of War may require, which said drawings and other information aforesaid shall be examined by him, and if he shall approve the same he shall so notify the said railway company of such approval and said company may then proceed to the erection of said bridge. The Secretary of War may make such alterations in such plans as he may deem necessary to the better protection of navigation; and such alterations shall be adopted by said railway company. The said railway company may, at any time, make any alterations deemed advisable to be made in said bridge, but must first submit such proposed alterations to the Secretary of War, and his approval shall be first had before they shall be authorized; and all expense attending any such changes shall be paid by the company.

Secretary of War to approve plans, etc.

Changes.

SEC. 7. That the said bridge herein authorized to be constructed shall be so kept and managed at all times as to afford proper means and ways for the passage of vessels under it, both by day and night. There shall be displayed on said bridge from sunset to sunrise such lights and signals as may be directed by the Light-House Board. And such changes shall be made, from time to time, in the structure of said bridge as the Secretary of War may direct, at the expense of said railway, in order the more effectually to preserve the free navigation of said river; or the said structure shall be altogether removed, if in the judgment of the Secretary of War the public good may require such removal, and without expense or charge to the United States.

Protection to navigation.

Lights, etc.

SEC. 8. That this Act shall be null and void unless actual construction of the bridge herein authorized be commenced within one year and completed within three years from the date of this Act being approved.

Time of construction.

SEC. 9. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendment.

Approved, February 28, 1903.

February 28, 1903.
Vol. 32, p. 921.

CHAP. 860.—An Act To authorize the building of a railroad bridge across the Tennessee River at a point between Lewis Bluff, in Morgan County, Alabama, and Guntersville, in Marshall County, Alabama.

Tennessee River.
Milton Humes, etc., may bridge, at Lewis Bluff, Ala.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be lawful for Milton Humes, R. E. Spragins, R. E. Pettus, T. W. Pratt, and Lawrence Cooper, their associates and assigns, to construct and maintain a bridge and approaches thereto over the Tennessee River at a point on said river between Lewis Bluff, in the county of Morgan, State of Alabama, and Guntersville, in the county of Marshall, State of Alabama, and to lay on or over said bridge a railroad track or tracks for the more perfect connection of any railroad or railroads that are or shall hereafter be constructed to the said river, on either or both sides thereof, at or opposite said point, under the limitations and conditions hereinafter provided.

Railway, wagon, and foot bridge.

Said bridge shall be constructed to provide for the passage of railway trains, and, at the option of the owners or builders thereof, may be used for the passage of wagons or vehicles of all kinds, for the transit of animals of all kinds, and for foot passengers, for such reasonable rates of toll as may be approved from time to time by the Secretary of War.

Toll.

Lawful structure and post route.

SEC. 2. That any bridge built under this Act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which no higher charge shall be made for the transmission over the same of the mails, troops, and munitions of war, or other property of the United States, than the rate per mile charged for the transportation of the same over the railroads or public highways leading to the said bridge, and it shall enjoy the rights and privileges of other post-roads in the United States.

Telegraph, etc., rights.

Equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies; and the United States shall have the right of way across said bridge and its approaches for postal, telegraph, and telephone purposes.

Drawbridge.

SEC. 3. That the said bridge shall be constructed with a draw or pivot span, which shall be over the main channel of the river at an accessible and navigable point, and the openings on each side of the pivot pier shall not be less than one hundred and sixty feet in the clear, and as nearly as practicable both of said openings shall be accessible at all stages of water; that the spans shall be not less than ten feet above extreme high-water mark, as understood at the point of location, to the lowest point of the superstructure of said bridge; that the piers and draw rests of said bridge shall be built parallel with the current at that stage of the river which is most important for navigation, and the bridge itself at right angles thereto; and that no riprap or other outside protection for imperfect foundations shall be permitted to approach nearer than four feet to the surface of the water at its extreme low stage, or otherwise to encroach upon the channel ways provided for in this Act:

Protection to navigation.

Proviso.
Opening draw.

Provided, That said draw shall be opened by the company or persons owning or controlling said bridge upon reasonable signal for the passage of boats or rafts, and there

shall be maintained, at the expense of the owners thereof, from sunset till sunrise, such lights or other signals on said bridge as the Light-House Board shall prescribe. Lights, etc.

SEC. 4. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of trains over the same upon payment of a reasonable compensation for such use; and in case the owner or owners of said bridge and the several railroad companies, or any of them, desiring such use shall fail to agree upon the sum or sums to be paid, and upon rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided by the Secretary of War upon a hearing of the allegations and proofs of the parties. Use by other roads. Compensation.

SEC. 5. That any bridge authorized to be constructed under this Act shall be built and located under and subject to such regulations for the security of navigation as the Secretary of War shall prescribe, and to secure that object the owner or owners thereof shall submit to the Secretary of War, for his examination and approval, a design and drawings of the bridge and a map of the location, giving, for the space of one mile above and one mile below the proposed location, the high and low water lines upon the banks of the river, the direction and strength of the current at all stages of the water, with the soundings, accurately showing the bed of the stream and the location of any other bridge or bridges, such map to be sufficiently in detail to enable the Secretary of War to judge of the proper location of said bridge, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until such plan and location of the bridge are approved by the Secretary of War the bridge shall not be commenced or built, and should any change be made in the plan of said bridge during the progress of construction, or after completion, such change shall be subject to the approval of the Secretary of War; and the owners of said bridge shall, at their own expense, make such changes therein as the Secretary of War may at any time order in the interest of navigation. Secretary of War to approve plans, etc. Changes.

SEC. 6. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment.

SEC. 7. That this Act shall be null and void unless the bridge herein authorized is commenced within one year and completed within three years from the date of approval hereof. Time of construction.

Approved, February 28, 1903.

CHAP. 971.—An Act To authorize the Pearl and Leaf Rivers Railroad Company to bridge Pearl River in the State of Mississippi. March 2, 1903. Vol. 32, p. 924.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Pearl and Leaf Rivers Railroad Company, a railroad corporation duly incorporated and organized under the laws of the State of Mississippi, its successors or assigns, be, and is hereby, authorized to construct and maintain a Pearl River, Miss. Pearl and Leaf Rivers Railroad Company may bridge, at Smiths Ferry.

railroad bridge, with single or double track, and approaches thereto, over and across the Pearl River at or near Smiths Ferry, in Lawrence County, State of Mississippi, subject to the conditions and limitations hereinafter specified.

Unobstructed navigation.

SEC. 2. That said bridge shall not interfere with the free navigation of said river beyond what may be necessary to carry into effect the rights and privileges herein granted;

Litigation.

and in case of any litigation arising under the provisions of this Act from any obstruction or alleged obstruction to the navigation of said stream, such litigation may be tried and determined by the proper circuit or district court of the United States within whose jurisdiction said bridge is located.

Lawful structure and post route.

SEC. 3. That any bridge built under this Act and subject to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which no higher charge shall be made for the transmission of mails and the troops and munitions of war of the United States over the same than the rate per mile paid for the transportation over the railroad or approaches leading to the said bridge; and it shall enjoy the rights and privileges of other post-roads in the United States, and equal privileges

Telegraph, etc., rights.

in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal, telegraph, and telephone purposes.

Drawbridge.

SEC. 4. That said bridge over said stream shall be constructed as a draw bridge. The drawspan shall be over the main channel of the said stream at an accessible navigable point and the openings on each side of the pivot pier shall be not less than one hundred and fifteen feet in the clear, unless otherwise expressly directed by the Secretary of War, and if so directed shall be according to such direction, and the said openings shall be accessible at all stages of water; and the spans shall be not less than thirty-six feet above extreme low water, as understood at the point of location, to the lowest part of the superstructure of the bridge; and the piers and draw shall be parallel with, and the bridge shall be at right angles to,

Opening draw.

the current of the stream; and the draw shall be opened promptly, upon reasonable signals, for the passage of

Lights, etc.

boats and other river craft; and said company, its successors or assigns, shall maintain at its own expense, from sunset till sunrise, throughout the season of navigation, such lights or other signals on said bridge as the Light-House Board may prescribe.

Use by other roads.

SEC. 5. That all railroad companies desiring the use of said bridge shall have and be entitled to equal rights and privileges relative to the passage of railway trains over the same and over approaches thereto, upon payment of

Compensation.

a reasonable compensation for such use; and in case the the owner or owners of said bridge and the several railroad companies, or any of them, desiring such use shall fail to agree upon the sum or sums to be paid and upon the rules and conditions to which each shall conform in using said bridge, all matters at issue between them shall be decided

by the Secretary of War upon a hearing of the allegations and proofs of the parties.

SEC. 6. That any bridge authorized to be constructed under this Act shall be built under and subject to such regulations for the security of navigation of said Pearl River as the Secretary of War shall prescribe; and to secure that object the said company shall submit to the Chief of Engineers and the Secretary of War for their examination and approval the plans and a design drawing of the bridge, and a map of location giving for the space of one-half mile above and one-half mile below the proposed location the topography of the banks of the river, the shore lines at high and low water, the direction and strength of currents at all stages, and soundings, accurately showing the bed of the stream and the location of any other bridge or bridges, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject; and until said plan and location of the bridge are approved by the Chief of Engineers and the Secretary of War said bridge shall not be built, or commenced, and no changes shall be made in said bridge during the progress of construction nor after completion, unless approved by the Chief of Engineers and the Secretary of War; and the said company shall, at its own expense, make from time to time such changes in said bridge as the Secretary of War may order in the interest of navigation.

Secretary of War to approve plans, etc.

Changes.

SEC. 7. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Amendment.

SEC. 8. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the date of approval hereof.

Time of construction.

Approved, March 2, 1903.

CHAP. 972.—An Act To amend an Act entitled "An Act authorizing the construction of a bridge across the Cumberland River at or near Carthage, Tennessee," approved March second, nineteen hundred and one.

March 2, 1903.

Vol. 32, p. 925.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That an Act entitled "An Act authorizing the construction of a bridge across the Cumberland River at or near Carthage, Tennessee," approved March second, nineteen hundred and one, be, and the same is hereby, revived and declared to be in full force and effect, and that section five of said Act is hereby amended so as to read as follows: "That this Act shall be null and void if said bridge is not commenced within one year and completed within three years from the first day of April, nineteen hundred and three."

Cumberland River.
Time extended for bridging, at Carthage, Tenn.
Vol. 31, p. 958, amended.

Approved, March 2, 1903.

March 2, 1903. Vol. 32, p. 926.

CHAP. 973.—An Act To authorize the construction of a bridge across the Arkansas River at or near Moors Rock, in the State of Arkansas.

Arkansas River.

Arkansas Coal and Mineral Railway Company may bridge, at Moors Rock, Ark.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Arkansas Coal and Mineral Railway Company, a corporation incorporated under the laws of the State of Arkansas, its successors and assigns, are hereby authorized to construct, operate, and maintain a bridge across the Arkansas River at Moors Rock, or within two miles above or below said Moors Rock, on the boundary line between the counties of Crawford and Sebastian. Said bridge shall be constructed in accordance with such plans as may be approved by the Secretary of War: *Provided*, That before the construction of any bridge herein authorized is commenced the said company shall submit to the Secretary of War, for his examination and approval, a design and drawing of such bridge and map of the location, giving sufficient information to enable the Secretary of War to fully and satisfactorily understand the subject; and unless the plan and location of such bridge are approved by the Secretary of War the structure shall not be built; and should any change be made in said bridge before or after completion, such changes shall likewise be subject to the approval of the Secretary of War; and any changes in said bridge which the Secretary of War may at any time deem necessary and order in the interests of navigation shall be made by the owners thereof at their expense: *Provided further*, That for the safety of vessels passing at night the owners of said bridge shall maintain thereon, at their own expense, from sunset to sunrise, such lights or other signals as the Light-House Board may prescribe.

Provisos.

Secretary of War to approve plans, etc.

Changes.

Lights, etc.

Use by other roads.

SEC. 2. That all railroad companies desiring the use of said bridge shall have equal rights and privileges relative to the passage of railway trains or cars over the same and over the approaches thereto upon payment of a reasonable compensation for such use; and in case the owners of said bridge and any railroad company desiring such use shall fail to agree upon the sums to be paid or the conditions to be observed, all matters at issue shall be decided by the Secretary of War upon hearing the allegations and proofs of the parties; and equal privileges in the use of said bridge shall be granted to telegraph and telephone companies.

Compensation.

Telegraph, etc., rights.

Lawful structure and post route.

SEC. 3. That the bridge constructed, maintained, and operated under this Act and according to its limitations shall be a lawful structure, and shall be recognized and known as a post route, upon which also no higher charge shall be made for the transportation over the same of the mails, the troops, and the munitions of war of the United States than the rate per mile paid for transportation of said mails, troops, and munitions over the railroads and public highways leading to said bridge; and the United States shall have the right of way for a postal telegraph across said bridge.

SEC. 4. That this Act shall be null and void if actual construction of the bridge herein authorized be not commenced within one year and completed within three years from the approval of this Act. Time of construction.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment.

Approved, March 2, 1903.

CHAP. 975.—An Act Making appropriation for the support of the Army for the fiscal year ending June thirtieth, nineteen hundred and four.

March 2, 1903.

Vol. 32, p. 927.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and they are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the support of the Army for the year ending June thirtieth, nineteen hundred and four: Army appropriations.

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QUARTERMASTER'S DEPARTMENT.

Quartermaster's Department.

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For the purchase of the necessary instruments, office furniture, stationery, and other authorized articles required for the equiqment and use of the officers' schools at the several military posts, twenty-five thousand dollars, to be immediately available. Equipment of post schools.

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ENGINEER DEPARTMENT.

Engineer Department.

ENGINEER DEPOTS: For incidental expenses of the depots, including fuel, lights, chemicals, stationery, hardware, machinery, pay of civilian clerks, mechanics, and laborers, extra-duty pay to soldiers necessarily employed for periods not less than ten days as artificers on work in addition to and not strictly in the line of their military duties, such as carpenters, blacksmiths, draftsmen, printers, lithographers, photographers, engine drivers, telegraph operators, teamsters, wheelwrights, masons, machinists, painters, overseers, laborers; repairs of, and for materials to repair, public buildings, machinery, and unforeseen expenses, eleven thousand five hundred dollars. Incidental expenses.

For purchase and repair of instruments, to be issued to officers of the Corps of Engineers and to officers detailed and on duty as acting engineer officers for use on public works and surveys, five thousand dollars. Purchase, etc., of instruments.

Engineer School, Washington, District of Columbia: Equipment and maintenance of the Engineer School of Application at Washington Barracks, District of Columbia, including purchase of instruments, machinery, implements, models, and materials, for the use of the school and for instruction of engineer troops in their special Engineer School, Washington Barracks, D. C. Equipment, etc.

duties as sappers and miners; for land and submarine mines, pontoniers, torpedo drill, and signaling; for purchase and binding of professional works of recent date treating of military and civil engineering and kindred scientific subjects, for the library of the United States Engineer School; for incidental expenses of the school, including fuel, lights, chemicals, stationery, hardware, machinery, and boats; for pay of civilian clerks, mechanics, and laborers; for extra-duty pay to soldiers necessarily employed for periods not less than ten days as artificers on work in addition to and not strictly in the line of their military duties, such as carpenters, blacksmiths, draftsmen, printers, lithographers, photographers, engine drivers, telegraph operators, teamsters, wheelwrights, masons, machinists, painters, overseers, laborers; for repairs of, and materials to repair, public buildings, and machinery; for unforeseen expenses, for travel expenses of officers on journeys approved by the Chief of Engineers and made for the purpose of instruction: *Provided*, That the traveling expenses herein provided for shall be in lieu of mileage and other allowances; and to provide means for the theoretical and practical instruction at the Engineer School of Application, by the purchase of textbooks, books of reference, scientific and professional papers, and for other absolutely necessary expenses, twenty-five thousand dollars.

Incidental expenses.

Travel expenses.

Proviso.

In lieu of mileage.

Books, etc.

Completion of building.

BUILDINGS, ENGINEER SCHOOL, WASHINGTON, DISTRICT OF COLUMBIA: For the completion of the establishment of the Engineer School and Post at Washington Barracks, District of Columbia, in accordance with plans submitted by the Chief of Engineers and approved by the Secretary of War, subject to such modifications as may prove to be expedient before or during construction, including buildings, roads, pavements, tree planting, grading, sea walls, sewerage, provision for lighting and protection against fire, and all purposes for the proper establishment of said Engineer School and Post not specifically mentioned herein, three hundred and sixty thousand dollars; this sum and all other funds heretofore appropriated for this purpose to be available until expended.

Available until expended.

Pontoon trains, etc.

For pontoon trains, intrenching tools, instruments, and drawing materials, and for purchase and printing of engineer manuals for use in the engineer equipment of troops, twenty-five thousand dollars.

Services.

For services of surveyors, draftsmen, photographers, master laborers, and clerks to engineer officers on the staff of division, corps, and department commanders, twenty-five thousand dollars.

Total for Engineer Department, four hundred and fifty-one thousand five hundred dollars.

Ordnance Department.

ORDNANCE DEPARTMENT.

*   *   *   *   *

Equipping organized militia.

ORDNANCE, ORDNANCE STORES, AND SUPPLIES: * * * *Provided further*, That for the purpose of furnishing the necessary articles requisite to fully arm, equip, and supply each regiment, battalion, squadron, company, troop,

battery, signal, engineer, and hospital corps and medical department of the organized militia of the several States, Territories, and the District of Columbia with the same armament and equipment as are now prescribed for corresponding branches of the line or staff in the Regular Army, without cost to said States, Territories, or the District of Columbia, but to remain the property of the United States, and to be accounted for in the manner now prescribed by law, the Secretary of War is hereby authorized, under such regulations as he may prescribe, on the requisitions of the governors of the several States and Territories, or the commanding general of the militia of the District of Columbia, to issue the said armament and equipment to the organized militia; and the sum of two million dollars is hereby appropriated and made immediately available until expended for the procurement and issue of the articles constituting the same.

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Approved, March 2, 1903.

March 2, 1903.
Vol. 32, p. 955.

CHAP. 990.—An Act To authorize the settlement of the accounts of officers of the Army.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the proper accounting officers of the Treasury be, and they are hereby, directed, in the settlement of the accounts of disbursing officers of the War Department, arising between the twenty-first day of April, eighteen hundred and ninety-eight, from which date war with Spain is declared to have existed, and the eighth day of July, nineteen hundred and one, inclusive, the date on which the last organization of the Volunteer Army was mustered out of the service of the United States, to allow such credits for payments and for losses of funds, vouchers, and property as may be recommended under authority of the Secretary of War by the heads of the military bureaus to which such accounts respectively pertain.

Army.
Allowance in accounts of officers for losses, war with Spain.

SEC. 2. That the accounts of military officers, whether of the line or staff, for Government property charged to them, shall be closed by the proper accounting officers whenever, in the judgment of the Secretary of War, it will be for the interest of the United States to do so: *Provided*, That such accounts originated subsequent to April twenty-first, eighteen hundred and ninety-eight, and prior to the ninth day of July, nineteen hundred and one: *Provided further*, That no settlement shall be made by the officers of the Treasury, under this Act, of the accounts of any officer whose combined responsibility for public money and Government property shall exceed the sum of five thousand dollars, and only of such officers of the Army in whose accounts there is no apparent fraud against the United States: *And provided further*, That this Act shall remain in force for two years from and after its passage, and no longer.

Accounts to be closed.

Provisos.
Date of accounts.

Limitation.

In effect two years.

Approved, March 3, 1903.

March 3, 1903. Vol. 32, p. 956. **CHAP. 992.**—An Act Making appropriations to provide for the expenses of the government of the District of Columbia for the fiscal year ending June thirtieth, nineteen hundred and four, and for other purposes.

District of Columbia appropriations. Half from District revenues. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the half of the following sums named, respectively, is hereby appropriated, out of any money in the Treasury not otherwise appropriated, and the other half out of the revenues of the District of Columbia, in full for the purposes following, being for the expenses of the government of the District of Columbia for the fiscal year ending June thirtieth, nineteen hundred and four, namely:

* * * * *

Washington Aqueduct.

WASHINGTON AQUEDUCT.

Maintenance. For operation, maintenance, and repair of the aqueduct and its accessories, including Conduit road, the Washington City reservoir and Washington Aqueduct tunnel, thirty-three thousand dollars.

Filtration plant. For continuing work on a slow sand filtration plant, and for each and every purpose connected therewith, including the preparation of plans, and for the purchase of such scientific books and periodicals as may be approved by the Secretary of War, six hundred thousand dollars, to be available immediately and until expended: *Provisos.* Contracts. *Provided*, That all contracts authorized under appropriations for the slow sand-filtration plant shall provide for the completion of the work on or before December first, nineteen hundred and four: Increased appropriation. *Provided further*, That the amount for which a contract or contracts may be entered into by the Secretary of War for such material and work as may be necessary for prosecuting the work on said slow sand-filtration plant, and for each and every purpose connected therewith to final completion within the shortest practicable time, or within which the materials may be purchased and the work done otherwise than by contract, to be paid for as appropriations may from time to time be made by law, is hereby increased from two million seven hundred and sixty-eight thousand four hundred and five dollars to three million four hundred and sixty-eight thousand four hundred and five dollars.

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Approved, March 3, 1903.

March 3, 1903. Vol. 32, p. 1011. **CHAP. 995.**—An Act Making appropriations for the support of the Military Academy for the fiscal year ending June thirtieth, nineteen hundred and four, and for other purposes.

Military Academy appropriations. *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the support of the Military Academy for the fiscal year ending June thirtieth, nineteen hundred and four.

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BUILDINGS AND GROUNDS.

Buildings and grounds.

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That section five of the Act entitled "An Act to increase the efficiency of the Army," approved February fourteenth, nineteen hundred and three, is hereby amended to read as follows:

General Staff Corps.

"SEC. 5. That the Chief of Artillery shall hereafter serve as an additional member of the General Staff, and by and with the advice and consent of the Senate shall have the rank, pay, and allowances of a brigadier-general, and when the next vacancy occurs in the office of colonel of artillery it shall not be filled, and thereafter the number of colonels of artillery shall not exceed thirteen; and the provisions of the foregoing sections of this Act shall take effect on August fifteenth, nineteen hundred and three."

Chief of Artillery to serve as additional member.

Rank, pay, etc.

Number of artillery colonels limited.

In effect Aug. 15, 1903.

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Approved, March 3, 1903.

CHAP. 1000.—An Act Making appropriations for fortifications and other works of defense, for the armament thereof, for the procurement of heavy ordnance for trial and service, and for other purposes.

March 3, 1903.

Vol. 32, p. 1024.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the sums of money herein provided for be, and the same are hereby, appropriated, out of any moneys in the Treasury not otherwise appropriated, to be available until expended, namely:

Fortifications appropriations.

FORTIFICATIONS AND OTHER WORKS OF DEFENSE.

For construction of gun and mortar batteries, two million two hundred and thirty-six thousand four hundred and twenty-five dollars.

Gun and mortar batteries.

For installation of range and position finders, two hundred and twenty-three thousand five hundred dollars.

Range finders.

For the procurement or reclamation of land, or right pertaining thereto, needed for the site, location, construction, or prosecution of works for fortifications and coast defenses, two hundred thousand dollars: *Provided*, That the Secretary of War is hereby authorized to purchase land on Cushings Island, Portland Harbor, Maine, for which appropriation was made in the Act making appropriations for fortifications and other works of defense, and so forth, approved June sixth, nineteen hundred and two, at such times and in such parcels and quantity as may appear to him to be for the best interests of the Government.

Sites.

Proviso. Purchases on Cushings Island.

Vol. 32, p. 305.

For purchase and installation of searchlights for the defenses of our most important harbors, one hundred and fifty thousand dollars.

Searchlights.

For the protection, preservation, and repair of fortifications for which there may be no special appropriation available, three hundred thousand dollars.

Preservation, etc.

Plans.

For preparation of plans for fortifications, five thousand dollars.

Electric plants.

For tools, electrical and engine supplies and appliances, to be furnished by the Engineer Department, for the use of the troops for maintaining and operating electric light and power plants in gun and mortar batteries, thirty-five thousand dollars.

Sea walls.

For construction of sea walls and embankments, eighty-nine thousand five hundred and seventy-five dollars.

Submarine mines.

For the construction of mining casemates, cable galleries, torpedo storehouses, cable tanks, and other structures necessary for the operation, preservation, and care of submarine mines and their accessories, fifty thousand dollars, to be expended by the Engineer Department.

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Contracts.

It shall be the duty of the Secretary of War to apply the money herein appropriated under the heading "Fortifications and other works of defense," in carrying on the various works, by contract or otherwise, as may be most economical and advantageous to the Government. Where said works are done by contract, such contract shall be made after sufficient public advertisement for proposals, in such manner and form as the Secretary of War shall prescribe; and such contracts shall be made with the lowest responsible bidders, accompanied by such securities as the Secretary of War shall require, conditioned for the faithful prosecution and completion of the work according to such contract.

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Purchases to be of American manufacture.
Exception.

That all material purchased under the foregoing provisions of this Act shall be of American manufacture, except in cases when, in the judgment of the Secretary of War, it is to the manifest interest of the United States to make purchases in limited quantities abroad, which material shall be admitted free of duty.

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Approved, March 3, 1903.

March 3, 1903.
Vol. 32, p. 1030.

CHAP. 1004.—An Act Granting the right of way to the Kenova and Big Sandy Railroad Company through the Government lands at Lock Number Two, Big Sandy River, and at Lock Number Three, Big Sandy River, both in Wayne County, West Virginia.

Locks 2 and 3, Big Sandy River, W. Va.
Kenova and Big Sandy Railroad Company granted right of way through.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Kenova and Big Sandy Railroad Company, a corporation created under and by virtue of the law of the State of West Virginia, its successors and assigns, be, and the same are hereby, empowered to locate, construct, and maintain its railroad through the lands belonging to the United States Government at Lock Number Two, Big Sandy River, and at Lock Number Three, Big Sandy River, in Wayne County, in the State of West Virginia, under such conditions and upon such lines, and of such

widths, as shall be determined and approved by the Secretary of War: *Provided*, That the said company shall pay to the United States such sum of money as the Secretary of War shall decide to be the value of the lands so occupied. *Proviso.* Payment.

SEC. 2. That the right of way granted herein under the provisions contained in this Act shall become inoperative and null and void unless the said company shall, within the term of two years from the first of January, nineteen hundred and three, have so far advanced the construction of said road as to satisfy the War Department that said company is lawfully and successfully established and that said road will be completed as proposed within a reasonable time. Time of construction.

SEC. 3. That if in the future, in the construction or operation by the United States of locks, dams, or other improvements to facilitate navigation on the Big Sandy River, or the tributaries thereof, it shall be necessary to utilize any land or other property of the said railroad company, the privilege shall be granted on such terms as shall be determined by the Secretary of War, and the said railroad company shall execute a valid agreement to that effect to be submitted to and approved by the said Secretary of War. Reversion.

SEC. 4. That the right to alter, amend, or repeal this Act is hereby expressly reserved. Amendment.

Approved, March 3, 1903.

CHAP. 1005.—An Act To authorize the construction of a bridge across Saint Francis River at or near the town of Saint Francis, Arkansas.

March 3, 1903.
Vol. 32, p. 1031.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That authority is hereby granted, and consent is hereby given, for the building of a wagon and foot bridge across Saint Francis River at or near the town of Saint Francis, in the State of Arkansas, by A. R. Vanmatre, a citizen of the State of Missouri: *Provided*, That the plans for such bridge shall first be submitted to and approved by the Secretary of War.

Saint Francis River, Ark. A. R. Vanmatre may bridge at Saint Francis.

Proviso. Secretary of War to approve plans.

SEC. 2. That said bridge shall be a lawful structure, and shall be known and recognized as a post route, and shall enjoy the rights and privileges of other post roads of the United States; and no charge shall be made for the transmission over the same of the mails, troops, and munitions of war of the United States. Equal privileges in the use of said bridge shall be granted to all telegraph and telephone companies, and the United States shall have the right of way across said bridge and its approaches for postal telegraph and telephone purposes; and any changes in the said bridge which the Secretary of War may require in the interests of navigation shall be made by the person or corporation owning or operating the same at their own expense.

Lawful structure and post route.

Telegraph, etc., rights.

Changes.

Construction. SEC. 3. That this Act shall be null and void if actual construction of the bridge herein authorized shall not be commenced within one year and completed within two years from the date of approval hereof.

Amendment. SEC. 4. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, March 3, 1903.

March 3, 1903.
Vol. 32, p. 1031.

CHAP. 1006.—An Act Making appropriations to supply deficiencies in the appropriations for the fiscal year ending June thirtieth, nineteen hundred and three, and for prior years, and for other purposes.

Deficiencies appropriations.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, to supply deficiencies in the appropriations for the fiscal year nineteen hundred and three, and for prior years, and for other objects hereinafter stated, namely:

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WAR DEPARTMENT.

* * * * *

Engineer Department.

ENGINEER DEPARTMENT.

New York Harbor.

HARBOR OF NEW YORK: Prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City: For pay of crews and maintenance of five steam tugs and three launches, ten thousand dollars.

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Buildings and grounds, D. C.

BUILDINGS AND GROUNDS IN AND AROUND WASHINGTON IN CHARGE OF THE CHIEF OF ENGINEERS.

Executive Mansion.
Grounds.

For improvement and maintenance of Executive Mansion grounds (within iron fence), one thousand dollars.

Repairs, etc.

EXECUTIVE MANSION: For care, repair, and refurnishing of Executive Mansion, ten thousand dollars, to be expended by contract or otherwise, as the President may determine.

Fuel.

For fuel for the Executive Mansion, greenhouses, and stable, three thousand dollars.

Lighting.

For gas, electric lights, pay of lamplighters, gas fitters and laborers, and so forth, four thousand dollars.

Conservatories.
Balance continued.
Vol. 32, p. 461.

The unexpended balance of the sum of three thousand dollars appropriated by the Act approved June twenty-eighth, nineteen hundred and two, for repairs to conservatory and greenhouses, Executive Mansion, is hereby made available for the reconstruction of said conservatory and greenhouses, and for each and every purpose connected therewith.

* * * * *

IMPROVING CHIPPEWA RIVER, WISCONSIN: To pay amounts found due by the accounting officers of the Treasury on account of the appropriation "Improving Chippewa River, Wisconsin," six dollars and one cent.

Chippewa River, Wis. Improvement of.

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JUDGMENT SUPREME COURT OF THE DISTRICT OF COLUMBIA.

Supreme court, D. C.

For payment of the owners of wharves, warehouses, wharf structures, and other improvements in and over the waters of the Potomac River south of Water street, in the city of Washington, and upon the adjoining land of the United States not in or over the said waters of the Potomac River, and the claim of Richard J. Beall, referred to in the decree passed by the supreme court of the District of Columbia in the case of the United States against Morris and others, which wharves, warehouses, wharf structures, and other improvements and the property concerning which the claim of the said Beall arose, have been included within the limits of the improvement of the Potomac River and its flats in charge of the Secretary of War, the sum of two hundred and thirty-two thousand one hundred and twenty-two dollars and four cents, which payments shall be made to and received by the respective owners of such wharves, warehouses, wharf structures, and other improvements and by said Beall in full discharge, acquittance, and release by such owners and said Beall to the United States of all their right, title, interest, and claim of every description, either at law or in equity, to compensation for wharves, warehouses, wharf structures, or for any other improvements or structures of any kind or character, as well as of all claim of such owners and said Beall on account of the impairment or injury to any rights whatsoever therein claimed or suffered by such owners or said Beall from the taking of said property or any other property, rights, or interests whatsoever, and the inclusion thereof within the limits of said improvement; and which payment shall be made upon orders of the said court to the persons and corporations who have already been determined by the said court to be the owners of some of said property, and also to the persons who shall hereafter be determined by said court to be the owners of the residue of said property; such orders to be passed from time to time upon application to the court therefor by the several persons so determined or who may be hereafter determined to be such owners; the appropriation herein made to be immediately available for the purposes specified.

Potomac flats judgment. Vol. 31, p. 956.

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Approved, March 3, 1903.

CHAP. 1007.—An Act Making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and four, and for other purposes.

March 3, 1903.

Vol. 32, p. 1083.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appro-

Sundry civil expenses appropriations.

priated, for the objects hereinafter expressed, for the fiscal year ending June thirtieth, nineteen hundred and four, namely:

* * * * *

War Department.

UNDER THE WAR DEPARTMENT.

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Buildings and grounds, District of Columbia.

BUILDINGS AND GROUNDS IN AND AROUND WASHINGTON.

Improvement and care.

For improvement and care of public grounds, District of Columbia, as follows:

For improvement and maintenance of grounds south of Executive Mansion, four thousand dollars.

For ordinary care of greenhouses and nursery, two thousand dollars.

For ordinary care of Lafayette Park, one thousand dollars.

For ordinary care of Franklin Park, one thousand dollars.

For improvement and ordinary care of Lincoln Park, two thousand dollars.

Monument Grounds, etc.

For care and improvement of Monument Grounds and annex (Potomac Park) to Monument Grounds, seven thousand dollars.

Playgrounds for children, etc.

The officer in charge of public buildings and grounds may hereafter authorize the temporary use of the Monument Grounds or grounds south of the Executive Mansion or other reservations in the District of Columbia for playgrounds for children and adults, under regulations to be prescribed by him.

Old canal.

Proviso. Expenditure.

For continuing improvement of reservation numbered seventeen, and site of old canal northwest of same, two thousand five hundred dollars: *Provided*, That no part thereof shall be expended upon other than property belonging to the United States.

For construction and repair of post-and-chain fences, repair of high iron fences, constructing stone coping about reservations, painting watchmen's lodges, iron fences, vases, lamps, and lamp-posts; manure, and hauling the same, and removing snow and ice; purchase and repair of seats and tools; trees, tree and plant stakes, labels, lime, whitewashing, and stock for nursery, flower pots, twine, baskets, wire, splints, moss, and lycopodium, to be purchased by contract or otherwise, as the Secretary of War may determine; care, construction, and repair of fountains; abating nuisances, cleaning statues, and repairing pedestals, sixteen thousand and fifty dollars.

For improvement, care, and maintenance of various reservations, twenty thousand dollars.

For improvement, care, and maintenance of Smithsonian grounds, two thousand five hundred dollars.

For improvement, care, and maintenance of Judiciary Park, two thousand five hundred dollars.

For laying asphalt walks in various reservations, two thousand dollars.

For broken-stone road covering for parks, two thousand dollars.

For curbing and flagging for park roads and walks, two thousand dollars.

One-half of the foregoing sums under "Buildings and grounds in and around Washington" shall be paid from the revenues of the District of Columbia and the other half from the Treasury of the United States. Half from District revenues.

Under appropriations herein contained no contract shall be made for making or repairing concrete or asphalt pavements in Washington City at a higher price than one dollar and seventy cents per square yard for a quality equal to the best laid in the District of Columbia prior to July first, eighteen hundred and eighty-six, and with a base of not less than six inches in thickness. Limit for concrete pavements.

For improvement, care, and maintenance of grounds of Executive Departments, one thousand dollars.

For such trees, shrubs, plants, fertilizers, and skilled labor for the grounds of the Library of Congress as may be requested by the superintendent of the Library building, one thousand dollars.

For such trees, shrubs, plants, fertilizers, and skilled labor for the grounds of the Capitol as may be requested by the Superintendent of the Capitol Building, three thousand dollars.

For improvement and maintenance of Executive Mansion grounds (within iron fence), four thousand dollars.

For the employment of an engineer by the officer in charge of public buildings and grounds, two thousand four hundred dollars.

For purchase and repair of machinery and tools for shops at nursery, two thousand dollars.

EXECUTIVE MANSION: For care, repair, and refurnishing of Executive Mansion, sixty thousand dollars, to be expended by contract or otherwise, as the President may determine. Executive Mansion. Repair, etc.

For fuel for the Executive Mansion, greenhouses, and stable, eight thousand dollars.

For care and maintenance of greenhouses, seven thousand dollars.

For repairs to and reerection of greenhouses, Executive Mansion, three thousand dollars.

To procure for the Executive Mansion an oil portrait of the President, two thousand five hundred dollars.

LIGHTING THE EXECUTIVE MANSION AND PUBLIC GROUNDS: For gas, pay of lamplighters, gas fitters, and laborers; purchase, erection, and repair of lamps and lamp-posts; purchase of matches, and repairs of all kinds; stoves, fuel, and lights for office and office stable, watchmen's lodges, and for the greenhouses at the nursery, twenty thousand dollars: *Provided*, That for each five-foot burner not connected with a meter in the lamps on the public grounds not more than twenty dollars shall be paid per lamp for gas, including lighting, cleaning, and keeping the lamps in repair, under any expenditure provided for in this Act; and said lamps shall burn every Lighting Executive Mansion and public grounds. *Provisos.* Maximum per lamp.

night, on the average, from fifteen minutes after sunset to forty-five minutes before sunrise; and authority is hereby given to substitute other illuminating material for the same or less price, and to use so much of the sum hereby appropriated as may be necessary for that purpose: *Provided further*, That three thousand four hundred dollars of the foregoing sum shall be paid from the revenues of the District of Columbia and the remainder from the Treasury of the United States.

Part from District revenues.

Electric lights.

For lighting six arc electric lights in Executive Mansion grounds within the iron fence, at not exceeding eighty dollars per light per annum, which shall cover the entire cost to the United States of lighting and maintaining in good order each electric light in said grounds, four hundred and eighty dollars.

For lighting six arc electric lights at the propagating gardens, at not exceeding eighty dollars per light per annum, which sum shall cover the entire cost of lighting and maintaining in good order each of said arc electric lights, four hundred and eighty dollars.

For lighting arc electric lights in public grounds as follows: For seven in grounds south of the Executive Mansion, thirty-two in Lafayette, Franklin, Judiciary, and Lincoln parks, and fourteen in grounds south of Executive Mansion and in Monument Park, at not exceeding eighty dollars per light per annum, which sum shall cover the entire cost of lighting and maintaining in good order each of said arc electric lights; in all, four thousand two hundred and forty dollars, one-half of which sum shall be paid from the revenues of the District of Columbia and the other half from the Treasury of the United States.

Repairs to water pipes.

REPAIR OF WATER PIPES: For repairing and extending water pipes, purchase of apparatus for cleaning them, purchase of hose, and for cleaning the springs and repairing and renewing the pipes of the same that supply the Capitol, the Executive Mansion, and the building for the State, War, and Navy Departments, two thousand five hundred dollars.

Government telegraph.

TELEGRAPH TO CONNECT THE CAPITOL WITH THE DEPARTMENTS AND GOVERNMENT PRINTING OFFICE: For care and repair of existing lines, one thousand five hundred dollars.

Washington Monument.

WASHINGTON MONUMENT: For the care and maintenance of the Washington Monument, namely: For one custodian, at one hundred dollars per month; one steam engineer, at eighty dollars per month; one assistant steam engineer, at sixty dollars per month; one fireman, at fifty dollars per month; one assistant fireman, at forty-five dollars per month; one conductor of elevator car, at seventy-five dollars per month; one attendant on floor, at sixty dollars per month; one attendant on top floor, at sixty dollars per month; three night and day watchmen, at sixty dollars per month each; in all, eight thousand five hundred and twenty dollars.

Expenses.

For fuel, lights, oil, waste, packing, tools, matches, paints, brushes, brooms, lanterns, rope, nails, screws,

lead, electric lights, heating apparatus, oil stoves for elevator car and upper and lower floors, repairs to engines, boilers, dynamos, elevator, and repairs of all kinds connected with the Monument and machinery, and purchase of all necessary articles for keeping the Monument, machinery, elevator, and electric plant in good order, three thousand dollars.

ENGINEER DEPARTMENT. Engineer Department.

Toward the construction of works on harbors and rivers, under contract and otherwise, and within the limits authorized by law, namely: Rivers and harbors.

Improving harbor at Charleston, South Carolina: For continuing improvement, sixty thousand dollars. Charleston, S. C.

For works authorized by the river and harbor Act of eighteen hundred and ninety-six, as follows: Vol. 29, p. 202.

Improving Cumberland Sound, Georgia and Florida: For continuing improvement, four hundred thousand dollars. Cumberland Sound, Ga. and Fla.

Improving Kentucky River, Kentucky: For continuing improvement, two hundred thousand dollars. Kentucky River.

Improving harbor at San Pedro, California: For continuing construction of breakwater, five hundred thousand dollars. San Pedro, Cal.

Improving Winyaw Bay, South Carolina: For continuing improvement of harbor at Winyaw Bay, one hundred thousand dollars. Winyaw Bay, S. C.

For works authorized by the river and harbor Act of eighteen hundred and ninety-nine, as follows: Vol. 30, p. 1121.

Improving harbor at Ashtabula, Ohio: For completing improvement, one hundred and eighteen thousand dollars. Ashtabula, Ohio.

Improving channel in Gowanus Bay, New York: For continuing improvement of Bay Ridge and Red Hook channels, two hundred and seventy-two thousand dollars. Gowanus Bay, New York Harbor.

Improving harbor at Black River, Ohio: For continuing improvements, nine thousand dollars. Black River, Ohio.

Improving harbor at Calumet, Illinois: For completing improvement, two hundred and four thousand four hundred and eighty dollars. Calumet, Ill.

Improving Mississippi River from the mouth of the Ohio to Minneapolis, Minnesota: For continuing improvement between Saint Paul and Minneapolis, two hundred and twenty-three thousand five hundred and seventy-nine dollars and thirty-three cents. Mississippi River. Saint Paul to Minneapolis, Minn.

Improving harbor at New York, New York: For continuing improvement of Ambrose Channel (formerly known as East Channel) across Sandy Hook Bar, seven hundred and thirty-three thousand dollars. New York, N. Y. Ambrose Channel.

Improving harbor at New Haven, Connecticut: For continuing improvement in accordance with the adopted and extended projects, sixty-three thousand and seventy-three dollars and ninety cents. New Haven, Conn.

Improving Ohio River below Pittsburg, Pennsylvania: For continuing construction of Dams Numbered Thirteen and Eighteen, four hundred and fifty thousand dollars. Ohio River. Dams 13 and 18.

San Francisco, Cal. Blossam Rock. Improving harbor at San Francisco, California: For continuing improvement by the removal of Blossam Rock, fifty thousand dollars.

Tampa Bay, Fla. Improving Tampa Bay, Florida: For continuing improvement of channel from the Gulf of Mexico to Port Tampa, one hundred and eighty-six thousand three hundred and thirty-seven dollars and seventy-six cents.

Toledo, Ohio. Improving harbor at Toledo, Ohio: For continuing improvement, one hundred and ninety thousand dollars.

Vol. 32, p. 331. For works authorized by the river and harbor Act of nineteen hundred and two, as follows:

Boston, Mass. Improving harbor at Boston, Massachusetts: For continuing improvement by providing channels thirty-five feet deep, and of authorized widths, from the navy-yard at Charlestown and the Chelsea and Charles river bridges to President Roads, and thence by route designated as numbered three through Broad Sound to the ocean, one hundred and fifty thousand dollars.

Fall River, Mass. Improving harbor at Fall River, Massachusetts: For completing improvement, one hundred and seventeen thousand four hundred and twelve dollars.

Gloucester, Mass. Improving harbor at Gloucester, Massachusetts: For continuing improvement in accordance with the approved and modified project, sixty thousand dollars.

New London, Conn. Improving harbor at New London, Connecticut: For continuing improvement, sixty thousand dollars.

Lake Erie, N. Y. Black Rock Harbor. Improving Lake Erie entrance to Black Rock Harbor and Erie Basin, New York: For continuing improvement, two hundred thousand dollars.

Arthur Kill, N. Y. and N. J. Improving Arthur Kill, New York and New Jersey: For continuing improvement of channel from Kill von Kull to Raritan Bay, in connection with adopted or modified project as authorized, one hundred and fifty thousand dollars.

Baltimore, Md. Southwest Baltimore. Improving Harbor at Baltimore, Maryland: For completing improvement of harbor at Southwest Baltimore (Spring Garden), two hundred and twenty-one thousand dollars.

Curtis Bay. For completing improvement of channel of Curtis Bay, Baltimore Harbor, one hundred and forty-six thousand dollars.

Hampton Roads, Va. Improving Hampton Roads, Virginia: For completing improvement by removal of Middle Ground Bar, two hundred and fifteen thousand dollars.

Norfolk, Va. Improving Harbor at Norfolk, Virginia: For continuing improvement by removal of Hospital Point, one hundred and eighty-three thousand nine hundred and fifty-seven dollars.

Savannah, Ga. Improving Harbor at Savannah, Georgia: For continuing improvement in accordance with approved or modified project as authorized, seven hundred and twenty thousand dollars.

Biscayne Bay, Fla. Improving Biscayne Bay, Florida: For continuing improvement, two hundred and fifty thousand dollars.

Mobile, Ala. Improving Harbor at Mobile, Alabama: For continuing improvement, two hundred thousand dollars.

Improving Harbor at Galveston, Texas: For continuing work of restoration of channel and jetties in accordance with approved or modified plan as authorized, three hundred thousand dollars. Galveston, Tex.

For continuing improvement of channel, Galveston, Texas, from outer end of inner bar to Fifty-first street, two hundred thousand dollars.

Improving harbor at Cleveland, Ohio: For continuing improvement in accordance with the plan for new harbor entrance and breakwater extension, two hundred and twenty-seven thousand five hundred dollars. Cleveland, Ohio.

Improving harbor at Conneaut, Ohio: For continuing improvement, ten thousand dollars. Conneaut, Ohio.

Improving harbor at Waukegan, Illinois: For completing improvements in accordance with the modified project as authorized, two hundred and forty thousand dollars. Waukegan, Ill.

Improving harbor at Ludington, Michigan: For completing improvement, one hundred and sixty-five thousand dollars. Ludington, Mich.

Improving harbor at Marquette, Michigan: For completing improvement, eighty thousand dollars. Marquette, Mich.

Improving harbor at Saugatuck and Kalamazoo River, Michigan: For continuing improvement according to the alternative project involving a new cut to Lake Michigan, one hundred thousand dollars. Saugatuck and Kalamazoo River, Mich.

Sturgeon Bay and Lake Michigan Ship Canal: For completing improvement of Sturgeon Bay and Lake Michigan Ship Canal and harbor of refuge connected therewith, one hundred and seventy-eight thousand dollars. Sturgeon Bay and Lake Michigan Ship Canal.

Improving harbor at Oakland, California: For continuing improvement, one hundred and thirty-one thousand dollars. Oakland, Cal.

Improving harbor at San Diego, California: For completing improvement, one hundred and ninety-two thousand eight hundred and fifty dollars. San Diego, Cal.

Improving San Pablo Bay, California: For continuing improvement by constructing a channel between the Straits of Karquines and the Golden Gate, off Point Pinole, Point Wilson, and Lone Tree Point, two hundred thousand dollars. San Pablo Bay, Cal.

Improving harbor at Tacoma, Washington: For continuing improvement, one hundred thousand dollars. Tacoma, Wash.

Improving Passaic River, New Jersey: For continuing improvement from the Montclair and Greenwood Lake Railroad bridge to deep water in Staten Island Sound, one hundred thousand dollars. Passaic River, N. J.

Improving Delaware River, Pennsylvania and New Jersey: For continuing improvement from Christian street, Philadelphia, to Delaware Bay, one million four hundred thousand dollars. Delaware River, Pa. and N. J.

Improving Appomattox River, Virginia: For continuing improvement by the deflection and improvement of the river at Petersburg, one hundred and seventy-five thousand dollars. Appomattox River, Va.

Improving Great Pedee River, South Carolina: For continuing improvement of upper portion of river, forty thousand dollars. Great Pedee River, S. C.

Saint Johns River, Fla.

Improving of Saint Johns River, Florida: For continuing improvement from Jacksonville to the ocean in accordance with the approved and modified project, three hundred and fifty thousand dollars.

Black Warrior, Warrior, and Tombigbee rivers, Ala.

Improving Black Warrior, Warrior, and Tombigbee rivers, Alabama: For continuing improvement by the construction of locks and dams numbered one, two, and three in the Tombigbee and Warrior rivers, two hundred thousand dollars.

Pascagoula River, Miss.

Improving Pascagoula River, Mississippi: For continuing improvement from three miles above the mouth of Dog River to the seventeen-foot contour in Mississippi Sound, one hundred thousand dollars.

Mississippi River, Southwest Pass.

Improving Southwest Pass, Mississippi River: For continuing improvement in accordance with the approved or modified project as authorized, one million dollars.

Galveston Ship Channel and Buffalo Bayou, Tex.

Improving Galveston Ship Channel and Buffalo Bayou, Texas: For continuing improvement to a uniform depth in divisions one and two, five hundred thousand dollars.

Trinity River, Tex.

Improving Trinity River, Texas: For continuing improvement by the construction of locks and dams and the operation of snag boats upon the river between the mouth and section one, and by clearing this portion of the river for through navigation, two hundred and fifty thousand dollars.

Ouachita River, Ark. and La.

Improving Ouachita River, Arkansas and Louisiana: For continuing improvement of Ouachita and Black rivers, Arkansas and Louisiana, by the construction of lock numbered four, near Monroe, Louisiana, and of lock numbered six, near Roland Raft, Arkansas, two hundred and fifty thousand dollars.

Mississippi River.
From mouth of Ohio River to the Missouri.

Improving Mississippi River from mouth of Ohio River to Minneapolis, Minnesota: For continuing improvement from the mouth of the Ohio River to the mouth of the Missouri River, six hundred and fifty thousand dollars.

From mouth of Missouri River to Saint Paul, Minn.

For continuing improvement from the mouth of the Missouri River to Saint Paul, Minnesota, four hundred thousand dollars.

Tennessee River, Colbert and Bee Tree shoals.

Improving Tennessee River below Chattanooga, Tennessee, Alabama, and Kentucky: For continuing improvement at Colbert and Bee Tree shoals by the construction of a lateral canal, three hundred and fifty thousand dollars.

Ohio River.
Dams 2, 3, 4, and 5.

Improving Ohio River below Pittsburg, Pennsylvania: For continuing construction of dams numbered two, three, four, and five, three hundred thousand dollars.

Lock, dam No. 8.

For continuing construction of lock at dam numbered eight, two hundred thousand dollars.

Lock, dam No. 11.

For continuing construction of lock at dam numbered eleven, two hundred thousand dollars.

Dam No. 37.

For continuing construction of dam numbered thirty-seven, four hundred thousand dollars.

Monongahela River, Pa.

Improving Monongahela River, Pennsylvania: For completing the reconstruction of lock and dam numbered two, four hundred and fifty-five thousand nine hundred and sixty-one dollars.

Improving Big Sandy River, West Virginia and Kentucky: For continuing improvement by the construction of locks and dams on Big Sandy River and Tug and Levisa forks of the same, fifty thousand dollars. Big Sandy River, W. Va.

Improving Detroit River, Michigan: For continuing improvement from Detroit to Lake Erie, in accordance with "Plan A," four hundred and fifty thousand dollars. Detroit River, Mich.

Improving Middle and West Neebish channels, Saint Marys River, Michigan: For continuing improvement, eight hundred thousand dollars. Saint Marys River, Mich.

Improving Stockton and Mormon channels, California: For continuing improvement by dredging and by the construction of a canal to divert the waters of Mormon Channel into Calaveras River at and near the city of Stockton, fifty thousand dollars. Stockton and Mormon channels, Cal.

Improving Mouth of Columbia River, Oregon and Washington: For continuing improvement in accordance with the approved or modified project, as authorized, one million dollars. Columbia River, Oreg. and Wash.

UNDER THE MISSISSIPPI RIVER COMMISSION. Mississippi River Commission.

Improving Mississippi River: For continuing improvement of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission, two million dollars. From Head of Passes to mouth of the Ohio. Expenses.

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ENLARGEMENT OF GOVERNORS ISLAND, NEW YORK: For continuing plan of improvement for the enlargement of Governors Island, New York Harbor, by wharf work, dredging, bulkhead, and filling, one hundred and fifty thousand dollars. Governors Island, N. Y.

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IMPROVEMENT OF THE YELLOWSTONE NATIONAL PARK: For the improvement of the Yellowstone National Park, in accordance with the approved project, including maintenance and repair of existing improvements, to be expended by and under the direction of the Secretary of War, two hundred and fifty thousand dollars, to be immediately available and to remain available until expended. Yellowstone Park.

Private parties or companies doing business in the Yellowstone National Park under authority from the Government may be permitted, in the discretion of the Secretary of War, to use electricity furnished by the electric lighting and power plant of Fort Yellowstone and Mammoth Hot Springs at actual cost to the Government for operation, maintenance, and depreciation of the plant and ten per centum additional, under such regulations as may be prescribed by the Secretary of War. Use of electricity by private parties.

MOUNT RAINIER NATIONAL PARK: To enable the Secretary of War to cause a survey to be made of the most practicable route for a wagon road into said park, and Mount Rainier Park.

toward the construction of said road after the survey herein provided for shall have been made, ten thousand dollars.

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Maps.

MAPS, WAR DEPARTMENT: For publication of maps for use of the War Department, inclusive of war maps, the unexpended balance of the sum of five thousand dollars appropriated for the fiscal year nineteen hundred and three is hereby reappropriated and made available for the fiscal year nineteen hundred and four.

Survey of northern and northwestern lakes.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES: For survey of northern and northwestern lakes, including all necessary expenses for preparing, correcting, extending, printing, and issuing charts and bulletins, and of investigating lake levels, with a view to their regulation, to be immediately available and to remain available until expended, one hundred and fifty thousand dollars.

Transportation of reports, etc.

TRANSPORTATION OF REPORTS AND MAPS TO FOREIGN COUNTRIES: For the transportation of reports and maps to foreign countries through the Smithsonian Institution, one hundred dollars.

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California Débris Commission.
Vol. 27, p. 507.

CALIFORNIA DÉBRIS COMMISSION: For defraying the expenses of the Commission in carrying on the work authorized by the Act of Congress approved March first, eighteen hundred and ninety-three, fifteen thousand dollars.

New York Harbor.

HARBOR OF NEW YORK: For prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City:

Inspectors, etc.

For pay of inspectors, deputy inspectors, office force, and expenses of office, ten thousand two hundred and sixty dollars;

Crews.

For pay of crews and maintenance of five steam tugs and three launches, sixty thousand dollars;

Steam tugs.

For generally overhauling and repairing steam tug Lamont, five thousand dollars;

For purchase or construction of one steam tug to replace the launches Active and Alert and the tug Argus, forty-five thousand dollars;

In all, one hundred and twenty thousand two hundred and sixty dollars.

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Navy Department.

NAVY DEPARTMENT.

Newport, R. I.
Purchase of wharf, etc.

PURCHASE OF WHARF AND ADJOINING LAND, NEWPORT, RHODE ISLAND: For the purchase by the Secretary of the Navy of a wharf and necessary adjoing land at Newport, Rhode Island, for the use of the Army and Navy, and for the Treasury and other Departments and branches of the Government service, and for the repair and improvement of the same: *Provided*, That said wharf property and any improvements thereon which may hereafter be made shall be under the control of the Secretary of the Navy, one hundred thousand dollars: *And provided further*, That

Provisos.
Control.
Jurisdiction.

exclusive jurisdiction shall have been ceded to the United States over said property by the State of Rhode Island.

* * * * *

Sec. 2. That all sums appropriated by this Act for salaries of officers and employees of the Government shall be in full for such salaries for the fiscal year nineteen hundred and four, and all laws or parts of laws in conflict with the provisions of this Act be, and the same are hereby, repealed. Sums for salaries to be in full.

Sec. 3. That no part of the appropriations herein made for printing and binding shall be used for any illustration, engraving, or photograph, in any document or report ordered printed by Congress unless the order to print expressly authorizes the same, nor in any document or report of any Executive Department or other Government establishment until the head of the Executive Department or Government establishment shall certify in the letter transmitting such report that the illustration is necessary and relates entirely to the transaction of public business. Illustrations. Special authority required for.

Approved, March 3, 1903.

CHAP. 1018.—An Act To authorize the court of county commissioners of Geneva County, Alabama, to construct a bridge across the Choctawhatchee River, in Geneva County, Alabama. March 3, 1903. Vol. 32, p. 1225.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the court of county commissioners of Geneva County, in the State of Alabama, be, and is hereby, authorized to construct, maintain, and operate a bridge across the Choctawhatchee River, a navigable stream, at or near the Martin Ferry, in said county of Geneva in said State. Choctawhatchee River, Ala. Geneva County may bridge at Martin Ferry.

Sec. 2. That said bridge shall be located and built under and subject to such regulations for the security of navigation as the Secretary of War may prescribe; and to secure that object the said court of county commissioners shall submit for his examination designs and drawings of the bridge and maps of the location, and until the said plans and location are approved by him the bridge shall not be commenced or built; and should any changes be made in said bridge, before or after completion, such changes shall be likewise subject to the approval of the Secretary of War. Secretary of War to approve plans, etc.

Sec. 3. That the said bridge shall be so kept and managed as to offer reasonable and proper means for the passage of vessels and other craft through or under the same; and for the safety of vessels passing at night there shall be displayed on said bridge from sunset to sunrise, at the expense of the owners thereof, such lights or other signals as the Light-House Board may prescribe. And any changes in said bridge which the Secretary of War may at any time deem necessary, and order in the interests of navigation, shall be made by the owners thereof at their own expense. Unobstructed navigation. Lights, etc. Changes.

Time of construction.

SEC. 4. That this Act shall be null and void if actual construction of the said bridge be not commenced in one year and completed in three years from the date hereof.

Amendment.

SEC. 5. That the right to alter, amend, or repeal this Act is hereby expressly reserved.

Approved, March 3, 1903.

RESOLUTIONS.

January 12, 1903.

Vol. 32, p. 1229.

[No. 2.] Joint Resolution Relating to military badges.

Military badges.

Chinese relief expedition badges may be worn.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the distinctive badges adopted by military societies of men who served in the armies and navies of the United States during the Chinese relief expedition of nineteen hundred may be worn upon all occasions of ceremony by officers and men of the Army and Navy of the United States who are members of said organization in their own right.

Approved, January 12, 1903.

January 30, 1903.

Vol. 32, p. 1229.

[No. 3.] Joint Resolution To carry into effect two resolutions of the Continental Congress directing monuments to be erected to the memory of Generals Francis Nash and William Lee Davidson, of North Carolina.

Appropriation for monument to Brigadier-General Francis Nash.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the sum of five thousand dollars be, and the same is hereby, appropriated for the erection of a monument in honor of the memory of Brigadier-General Francis Nash, of North Carolina, according to the resolution of Congress passed on the fourth day of November, seventeen hundred and seventy-seven.

Appropriation for monument to Brigadier-General William Lee Davidson.

SEC. 2. That a like sum of five thousand dollars be, and the same is hereby, appropriated for the erection of a monument in honor of the memory of Brigadier-General William Lee Davidson, of North Carolina, in accordance with the resolution of Congress passed on the twentieth day of September, seventeen hundred and eighty-one.

Sites.

SEC. 3. That the site for the location of said monuments, the designs for the same, the conduct of the work of erection, and the disbursement of the money hereinbefore appropriated shall be under the direction of the Secretary of War, who shall, however, act jointly with the governor of North Carolina as far as may be practicable in the selection of a location for said monuments.

Approved, January 30, 1903.

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